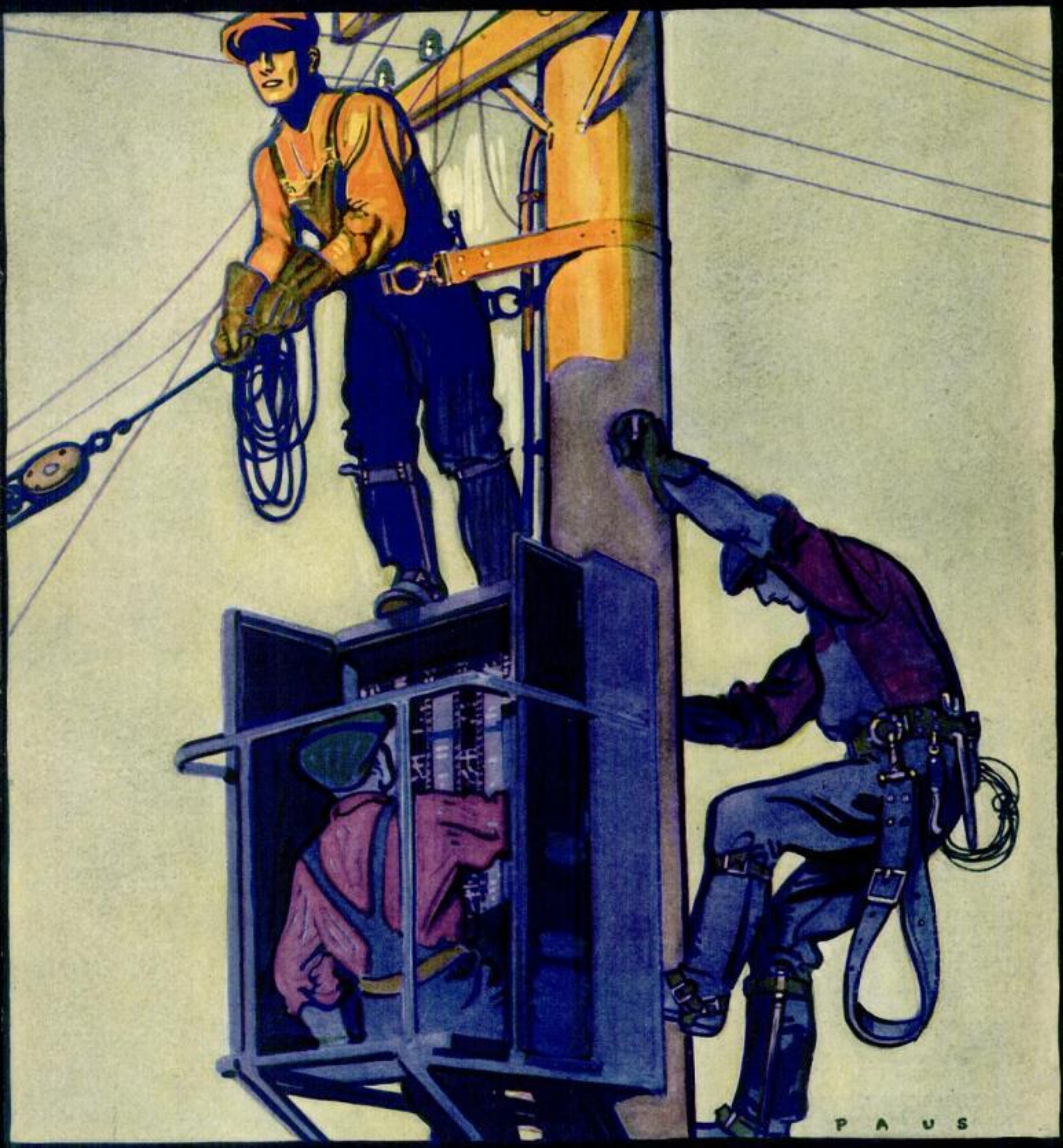
Popular Science

MONTHLY Founded 1872

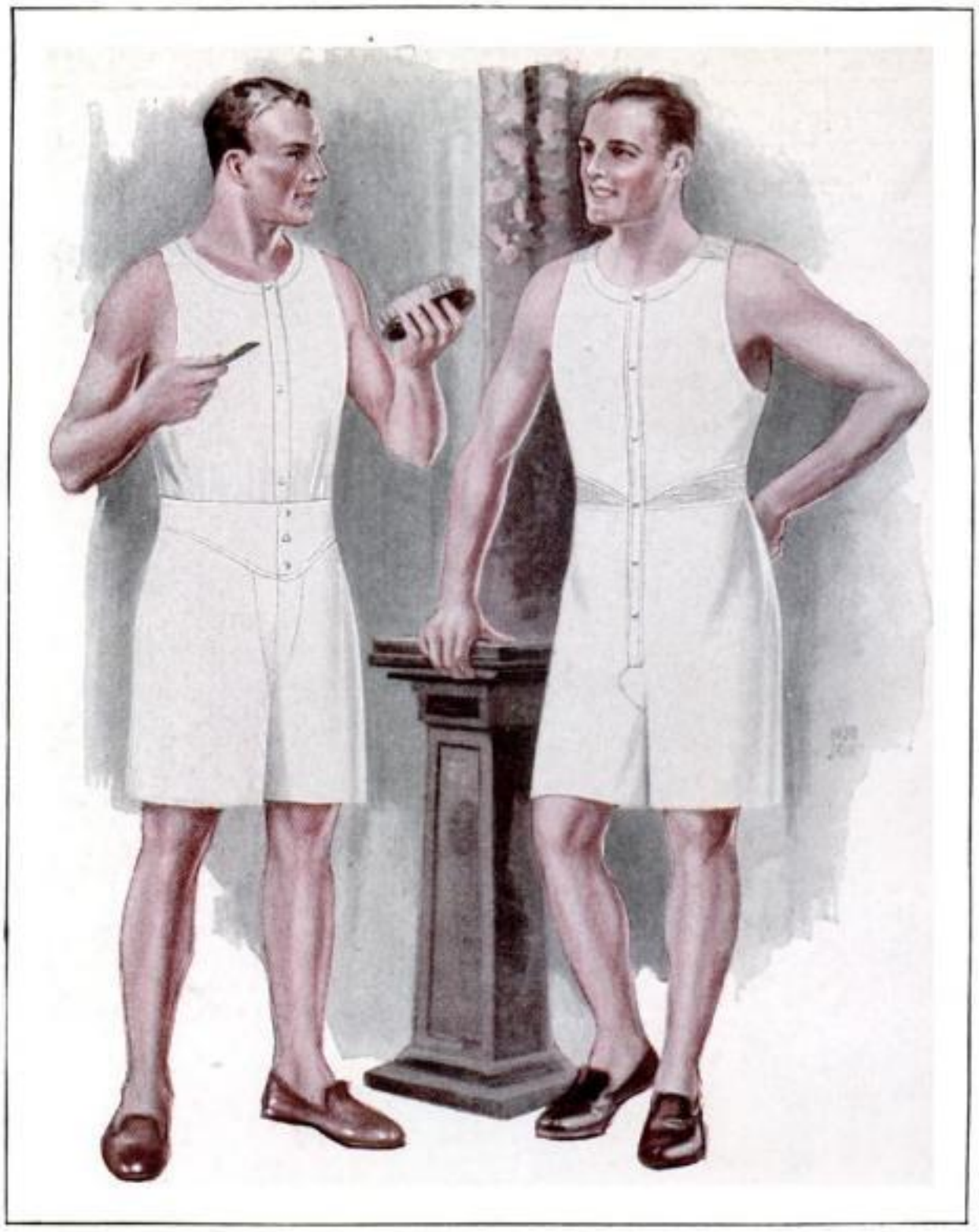
June
1927
25 cents



More Than 200 Fascinating New Ideas

In This Issue

"Next to Myself
I Like
'B.V.D.' Best"



How To Be Properly Fitted

"B.V.D." Union Suits are made in over sixty sizes, to fit men of widely varying builds.

Be correctly measured. Three simple encircling measurements —chest, waist and trunk—determine your proper size. If you have any difficulty in obtaining it, send your three measurements to the B. V. D. Service Bureau, 350 Broadway, New York, who will be glad to advise you.

"B.V.D."
Union Suit
Men's $1.50
Youths' 85c

"B.V.D."
Shirts and Drawers
85c the garment

Extra large sizes obtainable at an additional charge

Good Fit and Good Feeling

"B.V.D." feels so good because it *fits* so well. And the good feeling that millions hold *toward* "B.V.D." —the good feeling behind years of world-leading popularity — shows how men value better fit, cooler comfort and longer wear!

DEMAND TO SEE IT'S "B.V.D."

IT ALWAYS BEARS THIS RED WOVEN LABEL

MADE FOR THE B.V.D. BEST RETAIL TRADE

(Trade Mark Reg. U.S. Pat. Off. and Foreign Countries)

The B.V.D. Company, Inc., New York

Sole Makers of "B.V.D." Underwear

THE ardent admiration aroused everywhere by its charm of appearance is as nothing in comparison with the delight invariably inspired by the brilliant performance of the La Salle

Although production is large, the demand is so great that in equity and fairness, orders for the LaSalle are being filed and filled by Cadillac-LaSalle distributors in the order in which they are received

From $2495 to $2685—f. o. b. Detroit

CADILLAC MOTOR CAR COMPANY
DIVISION OF GENERAL MOTORS CORPORATION
DETROIT, MICHIGAN OSHAWA, CANADA

LA SALLE

MANUFACTURED · COMPLETELY · BY · THE · CADILLAC · MOTOR · CAR · COMPANY · WITHIN · ITS · OWN · PLANTS

This seal on a radio, tool or oil burner advertisement signifies the approval of the INSTITUTE OF STANDARDS. See page 8

WHAT IS NEW THIS MONTH

Table of Contents for June

LEADING ARTICLES

FICTION

RADIO

THE HOME WORKSHOP

Astronomy

Automobiles

Aviation

Exceptional People

June, 1927, Vol. 110, No. 6. **Popular Science Monthly** is published monthly at 250 Fourth Avenue, New York, N. Y., by the Popular Science Publishing Co., Inc. Entered as second-class matter Dec. 28, 1918, at the Post Office at New York under the act of March 3, 1879; additional entry as second-class matter at Chicago, Illinois. Entered as second-class matter at the Post Office Department, Canada. Printed in U. S. A. Single copy, 25 cents. Yearly subscriptions to United States, its possessions, and Canada, $2.50; foreign countries, $3.

In This Single Issue We Publish More Than 250 Articles Depicting the Latest Achievements and Discoveries in the World of Science and Invention

Explorations

Health and Hygiene

Hints for the Mechanic

Ideas for the Handy Man

Laboratory Discoveries

New Processes and Inventions

New Devices for the Home

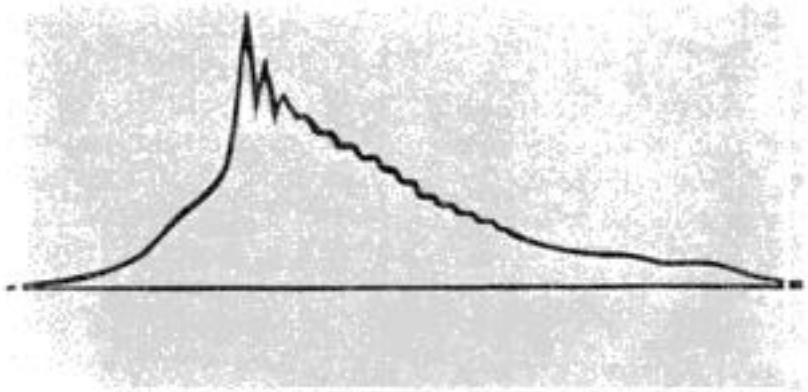
Photography

Radio

Unusual Facts and Ideas

Continued on Page 143

The first picture of that "knock"

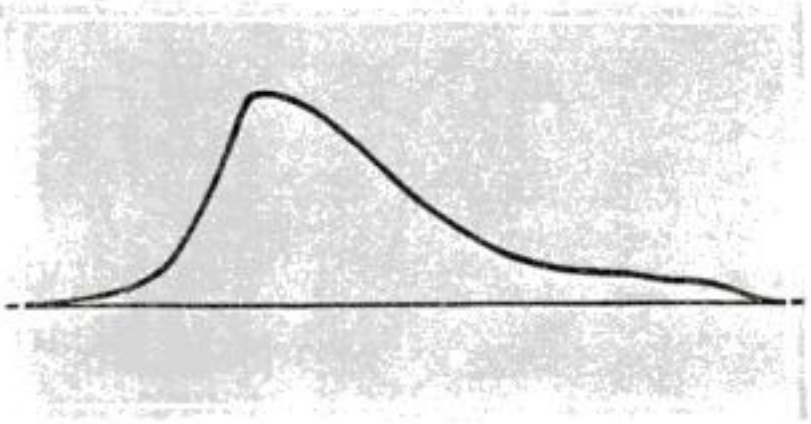


This is the "knock" in your motor

This shows photographically what occurs in the engine cylinder as carbon forms, when straight gasoline is used. The increased heat and pressure created by the carbon cause the gasoline to explode too quickly, with the result that there is an accumulation of high pressure heat waves which strike against the cylinder walls so violently as to produce an audible metallic sound. The bumps in the line are that "knock."

This is how "ETHYL" knocks it out

And this shows photographically what goes on in the same cylinder under the same conditions when straight gasoline is treated with "ETHYL" fluid. Note the absence of "knock-bumps"; the evenness of the pressure changes. The "ETHYL" fluid has neutralized the heating qualities of the carbon deposits and by maintaining the normal combustion rate of gasoline has turned the increased pressure due to carbon into increased power.



THESE PHOTOGRAPHS were made possible by a special instrument invented by General Motors Research Laboratories to find out what goes on in an automobile engine's cylinder when "knocking" occurs.

That invention led to the discovery that what you may call an "engine knock" or a "spark knock" is in reality a *fuel knock*. It is due to the tendency of a straight gasoline to explode too quickly as carbon forms and increases temperature and compression (pressure).

Having determined the character of "knocking," General Motors developed "ETHYL" fluid, a patented chemical compound which when added in very small quantities to straight gasoline forms Ethyl Gasoline, the most effective "anti-knock" fuel yet known.

Ethyl Gasoline transforms carbon deposits from a liability into an asset. It produces more power on hills and heavy roads. It gives a faster "pick-up," reduces gear-shifting, lessens vibration and engine wear and tear; and saves the trouble and expense of carbon removal.

Ethyl Gasoline has increased the motoring satisfaction of hundreds of thousands of car drivers. It is destined to play a still more important part in the automobile history of the future. TRY IT.

ETHYL GASOLINE CORPORATION
25 Broadway, New York

ETHYL GASOLINE is now generally available throughout the United States and Canada through the following oil companies, licensed to mix "ETHYL" fluid with gasoline. The "ETHYL" trademark on the pump is your protection.

* * *

Associated Oil Company • Atlantic Refining Co. • Beacon Oil Company • Continental Oil Company • Humble Oil & Refining Co. • Imperial Oil Limited (Canada) • Pennzoil Company • Refiners Oil Company • Spears & Riddle Co. • Spokane Oil & Refining Co. • Standard Oil Company (Indiana) • Standard Oil Company (Kentucky) • Standard Oil Company of Louisiana • Standard Oil Co. (Neb.) • Standard Oil Company (N. J.) • Sterling Oil Company • Union Oil Company of California • Walburn Petroleum Co. • Waverly Oil Works

ETHYL GASOLINE

ETHYL
BRAND OF ANTI-KNOCK COMPOUND
ETHYL GASOLINE CORPORATION
Knocks out that "knock"

A Four Square FINANCIAL PLAN *for* a YOUNG MARRIED COUPLE

By WALLACE AMES, *Financial Editor*

THE Financial Department's mail at the POPULAR SCIENCE MONTHLY office contains many letters relating to interesting financial plans and problems such as everyone confronts. We are yielding to the temptation to publish one of these letters together with our reply as we believe the subject will stimulate the thoughts of every reader who is seeking a sound program for his personal finances.

Because of the personal nature of the following letter the identity of the writer has been purposely deleted.

Mr. Wallace Ames,
Financial Editor,
POPULAR SCIENCE MONTHLY,
New York City.

Dear Mr. Ames,

My wife and I would appreciate your advice and suggestions in our financial situation. In order that you may be familiar with our case it is necessary to give you some personal facts.

I am thirty-two years old and have been married three years. Until now my salary has been $6,000 a year, but I have just been advanced to a higher position at a salary of $8,000 with an opportunity of an annual bonus of $500 to $1,000.

In the past, both before and since I was married I notice that soon after every increase in income my expenses grew up to it so that to date I have not accomplished much of anything towards future financial independence.

We have been getting along comfortably on $6,000 and my wife and I are very anxious to make this new increase in income be the beginning of real worthwhile financial progress.

THUS far we have laid by $1,000 and I am carrying $10,000 life insurance. Without stinting we can save and invest $2,000 to $2,500 a year from now on. If not asking too much, would you be good enough to write me suggesting the plan or program that you think a young married couple should follow under the circumstances I have outlined.

Here is Mr. Ames' reply to the above letter:

It is a pleasure to assist you in the formation of a sound getting ahead program. Judging by the information contained in your letter you are ideally situated to carry out what we term the Four-Square Financial Plan.

The four parts of this plan are the following:

1. Adequate savings bank balance for emergencies;
2. Adequate life insurance protection;
3. Home ownership;
4. Sound securities for independent income.

A Service for Readers

THIS Financial Department is to help readers in the establishment of proper financial programs at the beginning of their business careers; it assists those who have accumulated money in the proper investment of it.

The Editor of this Department is an authority on investment matters. He is ready to aid in personal investment problems. Advice will be gladly given regarding the proper investment of funds and proper plans of saving.

Address your inquiries to Wallace Ames, Financial Editor, POPULAR SCIENCE MONTHLY, 250 Fourth Avenue, New York. While investments obviously cannot be guaranteed by the Publisher, every effort will be made to insure that only advertisements of absolutely reliable companies are accepted.

In the first place we suggest that you leave the $1,000 you now have in the savings bank where it will draw 4% compound interest. This will give you available cash for any ordinary emergency or special purpose.

Next in logical order is life insurance. Your present insurance line, amounting to $10,000 would at 5% yield your wife an annual income of $500. This is not adequate. If you increase your insurance to $50,000 your wife would have an income (at 5%) of $2,500 in the event of your death. While this sum is less than each of you now spend to live we would consider it adequate protection.

At age 32 ordinary life insurance costs about $16.25 a thousand (dividends deducted) or $650 a year for $40,000 additional insurance. We believe you would find it convenient to take out several policies so arranged that you could pay about $54 each month in premiums instead of having larger sums come due less often.

After paying insurance premiums you have approximately $1,800 a year for investment. Of course you should anticipate owning your home. If you plan on one valued at $15,000 to $18,000 it would require a cash investment of say $9,000 in addition to the mortgage. With this in view invest $150 a month for five years in securities maturing in five years. You should then have, including interest earned, about $10,000 to $10,500. This finances your home purchase and leaves a starter for a long-term security buying program.

THE fourth step in your four-square financial program is to acquire sound securities for permanent independent income. For this purpose you simply continue to invest $1,800 annually ($150 a month) the same as you first did to buy your home. If you devote the first five years to home buying there remain thirteen years before you are fifty. Let us see what you can accumulate by that time.

According to the table published in the booklet of one investment banker $150 a month invested in their 6½% bonds builds a total worth of $36,595 in thirteen years, of which sum $13,195 is interest. Another bond house publishes a table of results of systematic investing which shows that $150 a month invested in bonds yielding an average of 6% will amount to $43,567 in fifteen years. (The figures in this table are in five-year periods only so we cannot ascertain the exact accumulation in thirteen years.)

Of course it is impractical to estimate down to the dollar how much you may accumulate over a period of years. But it is safe to approximate that in thirteen years, or by the time you reach fifty years of age, you may own $36,000 to $37,000 of bonds.

On the basis of the general plan outlined we would estimate your financial worth at fifty years of age as follows:

Equity in home	$ 9,000
Securities owned	36,000
Cash value of $50,000 life insurance	13,000

Retire *in 15 years*

on your Present *living Budget*

Follow the definite plan given in this book, and your financial independence is won.

The plan works just as surely, whether you are now earning $1,000 or $100,000 a year.

The way is certain—each step plainly indicated and absolutely safe—independent of luck, business genius or speculation.

Every fact has been harvested out of the 46 years' experience of Cochran & McCluer in the first mortgage investment banking business.

The plan is so simple, anyone can understand it—so definite anyone can follow it—and so certain, no one can fail.

In addition to the Financial Independence Plan and the unique budget schedule, the book gives suggestions that enable you to enjoy more of the good things of life, both while building your independent fortune and after you have attained it.

We invite the most skeptical to read this plain, straightforward, interesting book.

Phone, call or send coupon. We employ no salesmen, therefore none will call.

Mail this

Pc

Cochran & McCluer Co.
46 N. Dearborn St., Chicago, Ill.
Please send me, without obligation, your book, "Behind The Scenes Where Bonds Are Made."

Name.....

Street.....

City.....*State*.....

Cochran & McCluer Co.
46 North Dearborn Street
1109 Bryn Mawr Ave. 4613 N. Lincoln

Construction of Small Alternating Current Motors

By PROF. A. E. WATSON
Brown University

This book contains complete instructions for building small alternating current motors in several sizes. The designs will be found in harmony with those of the very best manufacturers and they can be worked out by the amateur for making useful instruments.

Fully Illustrated. **Price, $1.50**

POPULAR SCIENCE MONTHLY
250 Fourth Ave. **New York City**

A Four Square Financial Plan

(Continued from page 6)

Savings bank balance including accumulated interest	$ 2,000
Total financial worth	$60,000

We strongly recommend that you start the four-square financial plan and adhere to it as closely as possible.

To Help You Get Ahead

THE Booklets listed below will help every family in laying out a financial plan. They will be sent on request.

How to Build an Independent Income (1927 Edition)—Describes a plan for buying 6½% First Mortgage Bonds by payments of $10 or more a month, and shows the results that may be accomplished by systematic investment. Address: The F. H. Smith Company, Smith Building, Washington, D. C. Ask for Booklet 75.

The House Behind the Bonds reminds the investor of the importance, not only of studying the investment, but of checking up the banker who offers it. Address: Fidelity Bond & Mortgage Co. 1188 New York Life Building, Chicago, Ill.

Behind the Scenes where Bonds Are Made tells how you can retire in fifteen years and have an income equal to your present living budget. This booklet can be secured by writing to Cochran and McCluer Company, 46 North Dearborn Street, Chicago, Ill.

FIDELITY·MEANS·KEEPING·FAITH

Assurance

Life is full of promise when hearts are young. A good time to insure fulfillment by inaugurating a definite savings plan.

Fidelity's booklet, "The House Behind the Bonds," will help you. It explains the importance of buying first mortgage investments secured by the right *kind* and *amount* of physical property; and how the reputation of the issuing bond house contributes to this safeguard.

Whether or not you contemplate purchase of Fidelity 6½% Guaranteed Bonds, send for this booklet. No charge and no obligation.

FIDELITY BOND & MORTGAGE CO.
J. L. MENTEER, President — INCORPORATED 1853

660 Chemical Bldg., St. Louis
1188 New York Life Bldg., Chicago
378 Colorado Nat'l Bank Bldg., Denver

K870

FIDELITY·GUARANTEES·EVERY·BOND

SAFE BONDS *in Safe Cities ---*

that pay you 6½% on investment funds or monthly savings

MODERN, income-producing property offers exceptional security to the first mortgage investor, because the income from the property provides a constant source of funds from which interest payments can be made promptly, and a substantial part of the principal paid off each year.

It is such security as this, located in important and thriving cities of the United States—cities where rental demands are well established and where real estate values and economic conditions are sound—that protects your investments in SMITH BONDS.

Now you can get a 6½% return, with this strong security, and with safeguards that have resulted in our record of

No Loss to Any Investor in 54 Years

SMITH BONDS, in $1,000, $500 and $100 denominations, are sold outright for cash or under a plan that pays the full rate of bond interest—6½%—or regular monthly payments of $10, $20, $50 or more.

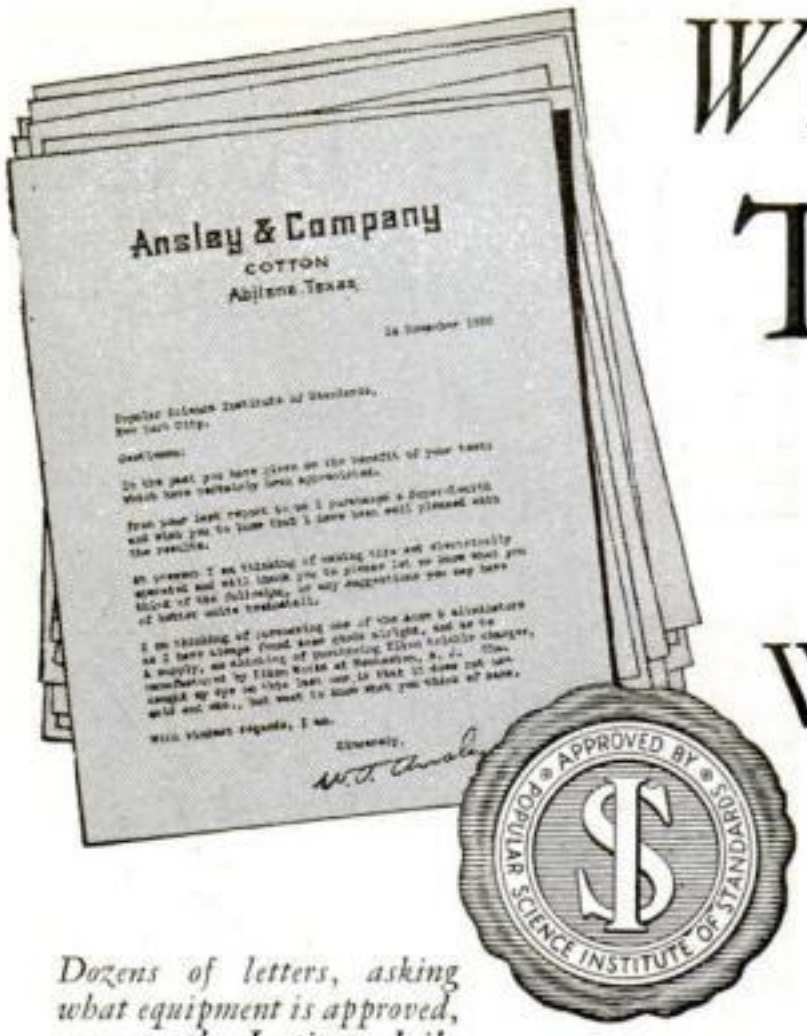
Mail the form below for our booklets, "Fifty-Four Years of Proven Safety" and "How to Build an Independent Income."

THE F. H. SMITH CO.
Founded 1873
SMITH BLDG., WASHINGTON, D. C.
285 MADISON AVE., NEW YORK, N. Y.

CHICAGO PHILADELPHIA BOSTON ST. LOUIS
PITTSBURGH BUFFALO MINNEAPOLIS ALBANY

Name..... 75-22

Address.....



Dozens of letters, asking what equipment is approved, come to the Institute daily

What THOUSANDS DID — Who Were Buying Radio, Tools and Oil Burners

TO AID readers in their buying problems, to determine that only reliable products were being advertised and to make POPULAR SCIENCE MONTHLY a still better magazine—these were the three aims the publishers had in mind in establishing the Popular Science Institute of Standards.

The Institute has been functioning three years now and these aims have been realized to an even greater extent than was expected. The fact that eleven thousand readers have come to the Popular Science Institute of Standards for advice in buying radio, tool and oil burning equipment shows that there was a real need for such a buying service as the Institute offers. Products offered for advertising have been carefully investigated with the result that advertising space has been refused to numerous concerns manufacturing equipment that failed to measure up to the rigorous standards of the Institute of Standards. And, in contacts with readers, comments are repeatedly made on the improvement and raised standard of the magazine.

At the time that the Institute was established, it was recognized that a staff of experts and the expenditure of considerable time, ingenuity and money would be necessary. Under the direction of Professor Collins P. Bliss, who is head of the mechanical engineering department and director of testing laboratories at New York University, a group of engineering and electrical experts have been constantly working. Their first problem was to devise tests and testing equipment. Practically nothing had been done along the lines of radio and tool testing previously, no apparatus had been designed with which to make such tests, nor had standards of efficiency been established. Ingenious and thorough test methods were worked out which have made it possible for the Institute to definitely separate reliable, dependable equipment from equipment of questionable worth. All this required more thought, labor and apparatus than was first estimated, but it has enabled the Popular Science Institute to answer definitely the question: "Will the tool or radio equipment give satisfactory service to our readers?"

In the case of oil burners, just as definite information has been obtained in a different manner. It was found that it was not feasible nor practical to *test* this type of equipment. To get authoritative information on the subject, it was necessary to question home owners who had been using an oil burner for one or more years. So POPULAR SCIENCE MONTHLY sent investigators into 1500 homes all over the country. Then 1500 other oil burner owners were questioned by mail. The combined results were tabulated and chartered, giving a clear picture of the findings.

As a result, the Popular Science Institute of Standards knows more about domestic oil burners on the market and the degree of satisfaction the different makes are giving than any other organization in the country. Not only Popular Science readers, but hundreds of other prospective oil burner owners who have heard of the survey, have made their selection of a burner on the Institute's advice. There is no charge for such service but information must be given on the size of the house to be heated, its heating system, annual coal consumption, and as to whether gas and electricity are installed. Such information is essential if the Institute is to advise authoritatively.

AS TO the principles by which the Institute is governed, it must, and does, present only the actual facts discovered. It is for this reason that its findings are entirely unbiased and have no relation whatever to the advertising side of the radio, tool and oil burning industries in connection with POPULAR SCIENCE MONTHLY. The Institute of Standards approves on the evidence presented by its tests and investigations and those are made as extensive as is necessary to bring out the truth regarding a product.

The Institute's advice is at the disposal of every reader who is buying radio, tool or oil burning equipment. For lists of such products that are approved, and for other information, address the Popular Science Institute of Standards, 250 Fourth Ave., New York, N. Y.

Popuar Science Monthly
GUARANTEE

The above seal on an advertisement indicates that the products referred to have been approved after test by the Popular Science Institute of Standards.

POPULAR SCIENCE MONTHLY guarantees every article of merchandise advertised in its columns. Readers who buy products advertised in POPULAR SCIENCE MONTHLY may expect them to give absolute satisfaction under normal and proper use. Our readers in buying these products are guaranteed this satisfaction by POPULAR SCIENCE MONTHLY. THE PUBLISHERS

Steel Makers use Tycos - the Sixth Sense

THE making of steel and steel products has become a "fine art" through the introduction of exact control and regulation of heat. From the first smelting of the iron ore to the making of fourteen inch navy guns or the hair spring of a wrist watch the steel is constantly going through heat treating processes. And *Tycos* Instruments for Indicating, Recording and Controlling of heat are in constant use for eliminating spoilage and insuring uniformity of quality that is the essential of mass production.

Tycos Instruments are the Sixth Sense of the Steel Industry—and every other industry where heat processes are used. *Tycos* Instruments insure the accuracy of automatic control.

Whether you make steel by the ton or bread or paint or perfumery or phonograph records or any other product that requires heat treatment in its making you can use *Tycos* "Sixth Sense" in your plant.

Tycos Engineers have effected substantial economy for manufacturers in every line of industry by applying the *Tycos* "Sixth Sense." Whatever your problem in the indicating, recording or controlling of heat, there is a *Tycos* Instrument to serve you. Write us for literature on any instrument, or type of instrument, and it will be sent promptly. Or, if you prefer, our engineers will consult with you on the application of the *Tycos* Sixth Sense in your plant.

Tycos for the Home

Tycos Office Thermometers
An aid in promoting human efficiency.

Tycos Bath Thermometers
To enable you to get the most good from your bath.

Taylor Home Set
Bake Oven Thermometer, Candy Thermometer, Sugar Meter. The secret of accurate results in cooking.

Tycos Wall Thermometers
To help you maintain a temperature in your house conducive to good health.

Taylor Quality Compasses
To show you the right way in unfamiliar country.

Tycos Fever Thermometers
A necessity in every home.

Tycos Stormoguide
Forecasts the weather twenty-four hours ahead with dependable accuracy.

Tycos Hygrometer
To enable you to keep the humidity of the atmosphere in your home correct at all times.

Tycos for the Medical Profession

Tycos Sphygmomanometer, Pocket and Office types.
Tycos Urinalysis Glassware.
Tycos Fever Thermometers.

Your dealer will show them to you. Ask us, on a postal, for booklets on any of the above

Write for Bulletin

Taylor Instrument Companies

Main Office and Factory
ROCHESTER, N. Y. - - U.S.A.
Canadian Plant: *Tycos* BUILDING, TORONTO
SHORT & MASON, Ltd. Manufacturing Distributors in Great Britain

THE ~ SIXTH ~ SENSE ~ OF ~ INDUSTRY

Tycos Temperature Instruments

INDICATING · RECORDING · CONTROLLING

This seal on a radio, tool or oil burner advertisement signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

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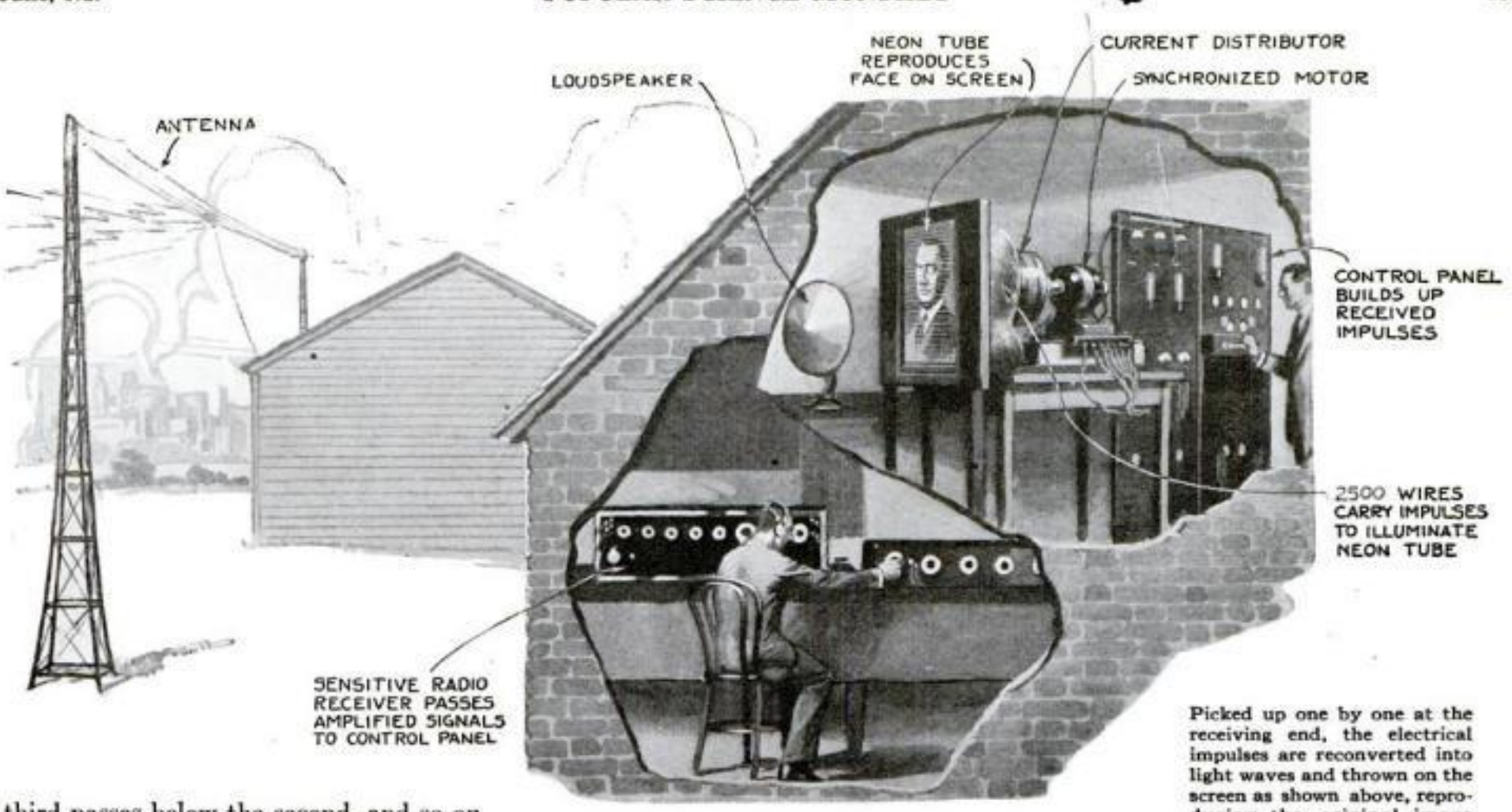


RECEIVING STATION

Picked up one by one at the receiving end, the electrical impulses are reconverted into light waves and thrown on the screen as shown above, reproducing the original image

third passes below the second, and so on until the entire face has been scanned by the light beam in fifty parallel lines. The procedure is repeated again and again, in a succession of pictures. Meanwhile the photo-electric cell is recording every variation in light and shadow in terms of electric current.

Of course, you cannot see the moving beam of light; for, you remember, it scans the entire face once every eighteenth of a second. It moves so swiftly that it appears as if the face were bathed in a continuous flood of light. Yet the electric eye follows every move.

The electric current which bears the record of what this eye sees is, however, too feeble to do the work required of it. So it passes through vacuum tube amplifiers, where it is magnified 5,000,000,000,000,000 times. Then, from the antenna of station 3XN, the magnified impulses ride out into space on the back of a radio carrier wave—an electrical "flying picture" of the comedian there in the studio.

Enter, now, another room, miles away, where these picture impulses are received. You will observe that they are reproduced in one of two different ways. If only one individual is "looking in," he sits at a cabinet containing a small, translucent screen measuring about two by three inches. On the screen the animated face of the comedian is registered clearly and sharply, while his voice is heard from a radio loudspeaker. But behind the little screen astonishing things are happening.

Reaching the receiving antenna, the picture impulses are picked up and amplified much as in ordinary radio reception. Then they are led to a tube filled with neon gas and containing two electrodes. As the current leaps across the electrodes, each impulse causes the gas to glow. This flash of light is strong or weak, according to the light or shadow of the particular fragment of the face to which the electrical impulse corresponds.

At the "seeing" end—W. S. Gifford, president of the American Telephone and Telegraph Company, watching Secretary Hoover in Washington as he talks to him from New York. Standing is Dr. H. E. Ives, who directed development of the television apparatus

Between the neon light and the screen is a second revolving perforated disk, an exact duplicate of the disk at 3XN and timed to run at precisely the same speed. Through the perforations each successive fragment of light is made to land in its appointed place on the screen and at precisely the right time to play its rôle in reproducing the original face.

If a number of persons are to view the image, the screen is much larger, measuring perhaps two by three feet, and consists of a very long neon tube folded back and forth to form a large rectangular grid or screen. The tube is divided into 2500 little sections, arranged in fifty parallel lines of fifty sections each, each section corresponding to one of the fragments of the face scanned by the photo-electric cell in the transmitting station.

Within each of the 2500 sections are two electrodes, connected by wires with an apparatus for making and breaking electrical contacts. This is a brush mounted on a wheel which revolves in exact time with the scanning disk at 3XN. As each electrical bit of flying picture is received, the brush delivers it to the proper wires leading to its appointed section on the screen. There, in passing across the electrodes, it causes a flash of light similar in location and intensity to the corresponding spot of light on the original face.

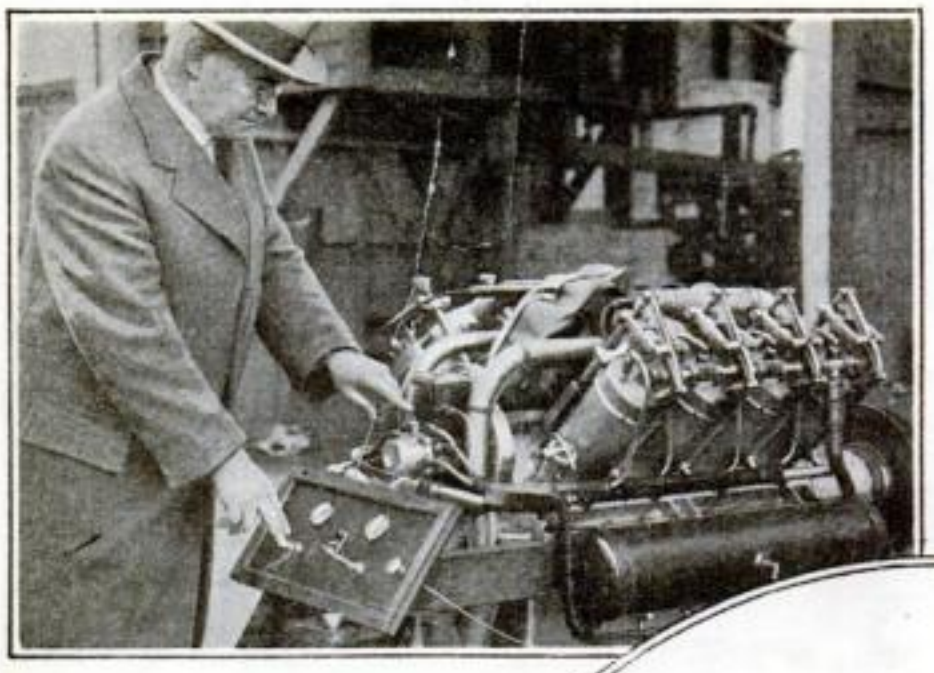
Eighteen times a second, each of the little sections thus shines forth in turn. The succession of flashes is so swift that human eyes cannot note them separately. The observer sees them not as a series of distinct flashes, but as an entire picture. The picture is viewed either directly on the gridlike tube or through a translucent screen.

THE system is virtually the same by wire as by radio. Its success lies largely in the remarkable synchronizing of motors controlling the apparatus in both the sending and receiving stations. Were it not for this, the thousands of little picture units would fail to reach their proper destinations, and the result would be a blur. To aid in the timing, a secondary or governing motor is employed in connection with the main motor in each station. In radio vision the timing process is controlled electrically over a wave length different from the one used in actual transmission. The voice is carried on a third wave length. In wired television three separate wires are used.

The development of this marvelous system was effected (Continued on page 130)

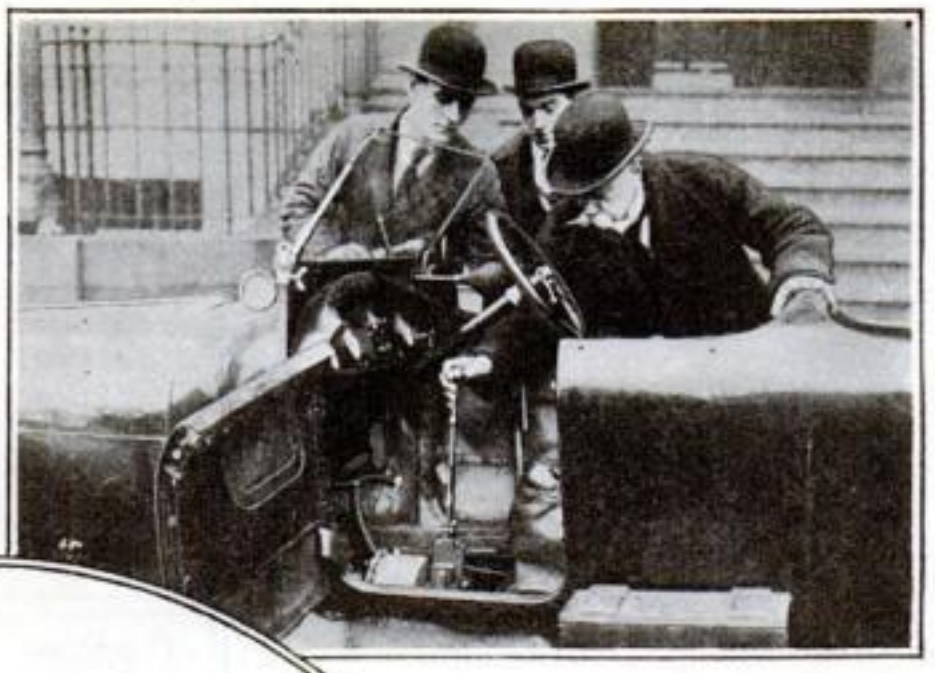
New Marvels of Ingenuity

A Light That Pierces Fog — Pictures on the Clouds—Other Amazing Ideas and Discoveries



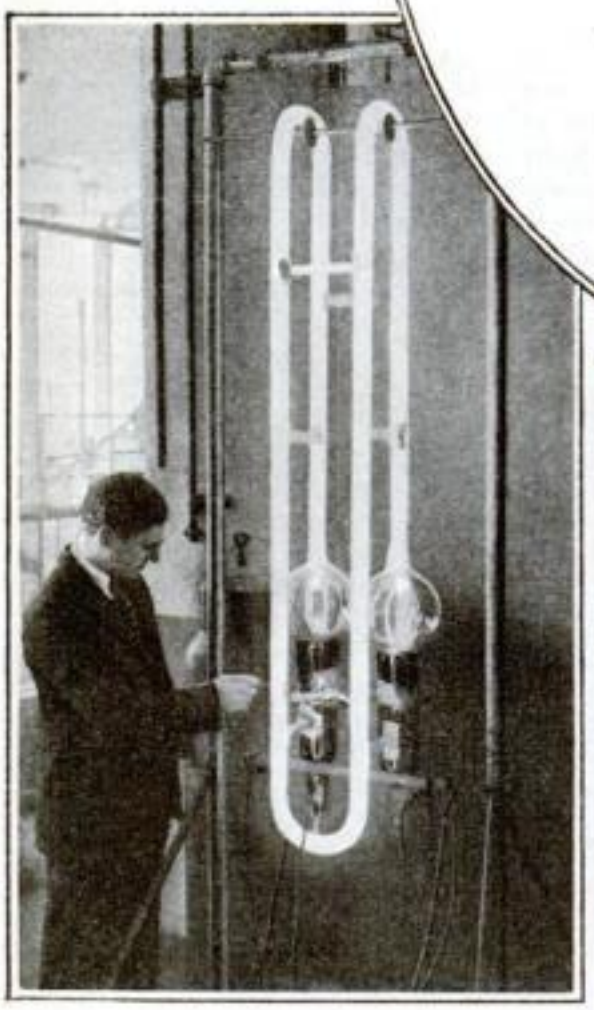
A New Self-Starter for Airplanes

Press a button, and the airplane engine roars into action! This new self-starter for airplanes, invented by C. F. Heywood, of Detroit, Mich., makes it unnecessary for a mechanic to spin the propeller by hand. Compressed air controlled from the pilot's cockpit turns over the engine. The apparatus weighs less than 20 pounds



Turbine Drives Gearless Car

The latest development in gearless motor cars, the recent invention of James Fraser, of Glasgow, Scotland (at the right), is based on the turbine principle. The engine has a series of revolving blades which, through the medium of a liquid, transmit the motor's power to another series of blades connected with the rear axle drive



Strange Light Pierces Fog

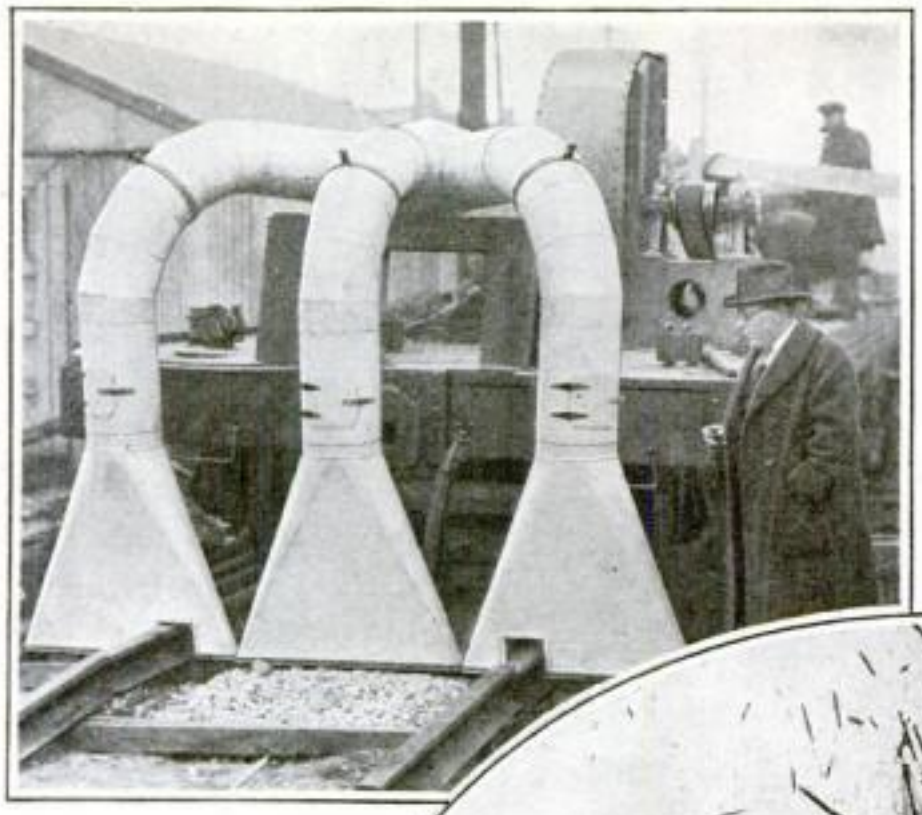
A wonderful new light designed to guide airplanes safely to their landing fields in bad weather gives off intense orange-red rays from the huge electric tube shown above. These rays, because of their long wave length, are said to penetrate heavy fog. According to the inventor, R. R. Machlett, the tube contains neon gas and a mirror of the rare and costly metal, caesium. Six of the new lamps will be mounted on a 150-foot tower at the air mail station at New Brunswick, N. J.

Power and Speed!

This picture shows Gar Wood's speedboat, *Miss America V* immediately after setting a new world's salt water speed record of 80.46 miles an hour at Miami, Florida. The famous speedboat pilot is seen at the wheel

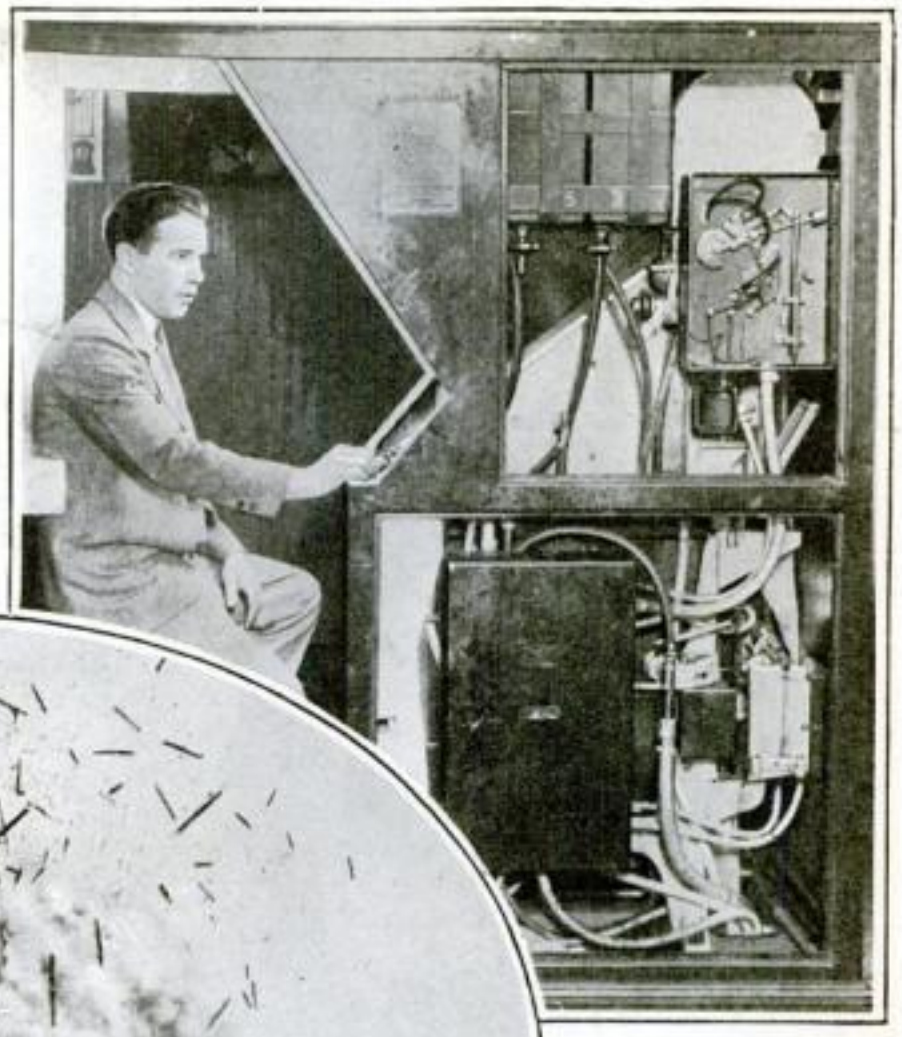
Dangles in a Basket

To study the wonderful formation of the famous Natural Bridge at Staunton, Va., Dr. Chester A. Reeds of the American Museum of Natural History recently was let down from the top of the arch, which is fifty feet higher than Niagara Falls. At the left he is seen at a height of about 200 feet



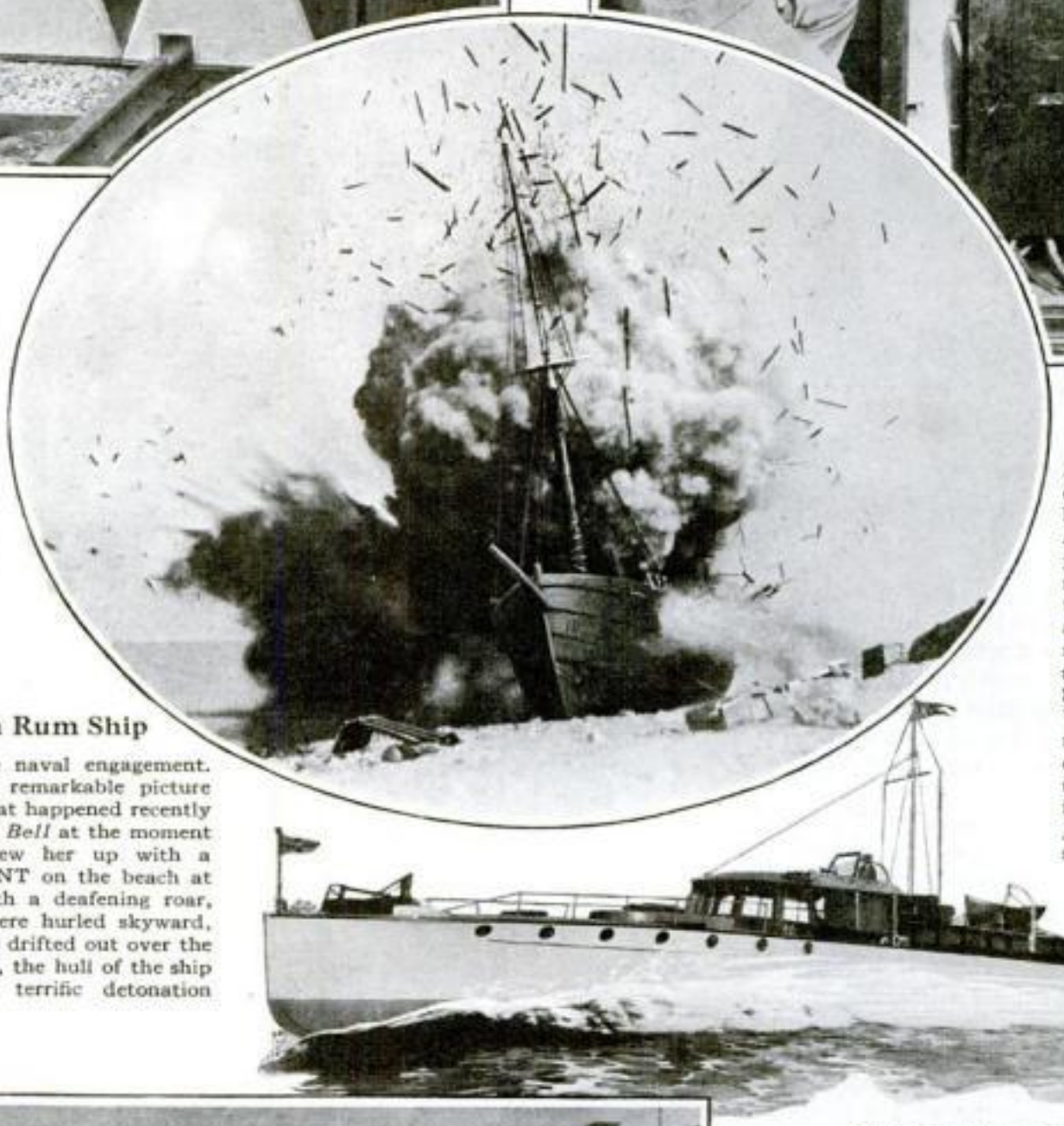
Housecleaning on the Tracks

Clear the tracks; here comes the vacuum cleaner! Walter M. Spring, research engineer, is the inventor of this strange apparatus for cleaning cinders and refuse from trap rock roadbeds. It consists of three huge suction chambers, the bases of which run close to the track bed. He claims it will operate at a speed of thirty miles an hour



Wins a Million for Invention

Every inventor's dream of a million-dollar idea has just been realized by Anatol Josepho. This young Russian photographer recently received that sum for his remarkable automatic photographer, previously described in POPULAR SCIENCE MONTHLY. With it anyone can make a strip of photos of himself in eight minutes—all for twenty-five cents. Above, Josepho is seen demonstrating his invention

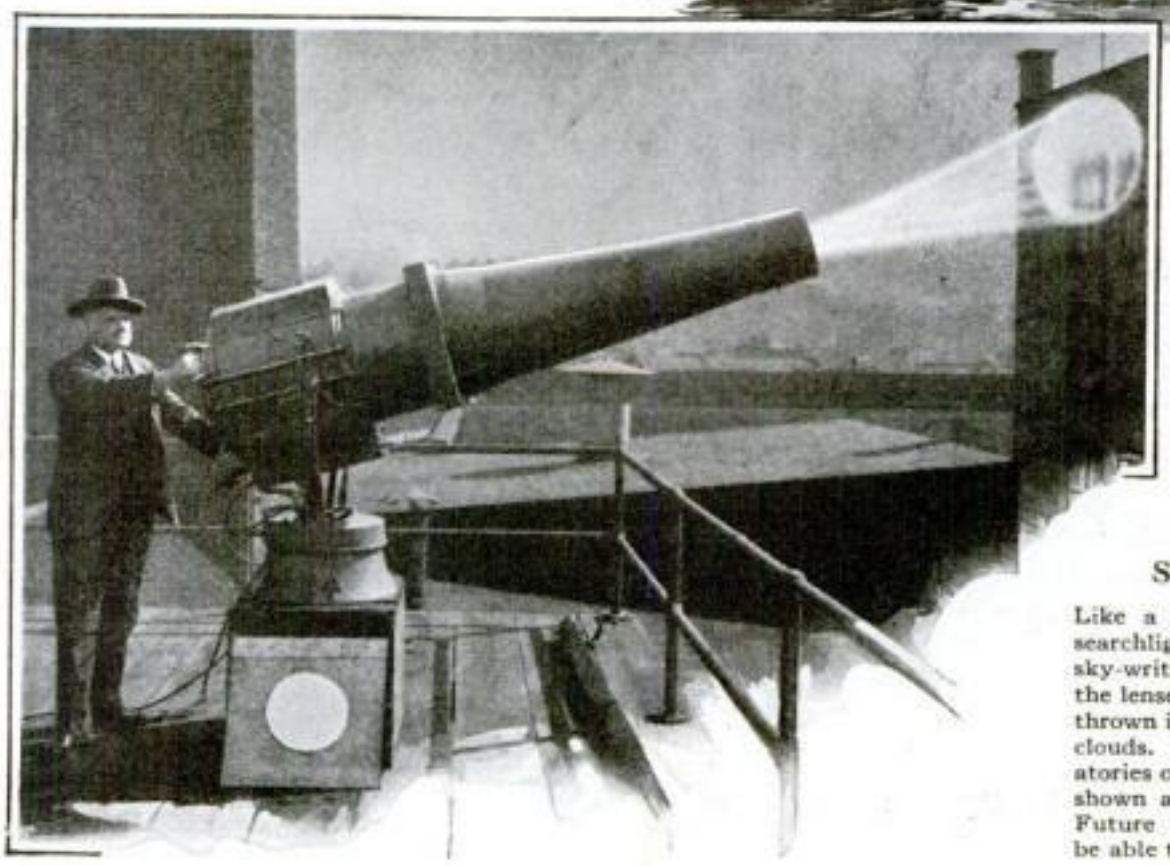


The End of a Rum Ship

It looks like a fierce naval engagement. Actually, though, the remarkable picture in the circle shows what happened recently to the rum ship *W. T. Bell* at the moment Coast Guardsmen blew her up with a hundred pounds of TNT on the beach at Bayville, N. Y. With a deafening roar, showers of timbers were hurled skyward, while billows of smoke drifted out over the sea. Strangely enough, the hull of the ship remained after the terrific detonation

The Latest—a "Zeppelin" Cruiser

Ideas borrowed from Zeppelin construction are embodied in a revolutionary type of express cruiser built in Germany for Otto H. Kahn, prominent American financier. From stem to stern the hull is reinforced by a metal framework of the light alloys used in building airships. In addition, the ribs, instead of crossing the hull squarely, are placed slantwise, to give greater strength. Three 480-horsepower engines are suspended from the metal frame in such a way as to eliminate vibration. They are said to drive the 73-foot craft at a speed of thirty-six miles an hour, making it one of the fastest boats of its size



Shoots Pictures on the Clouds

Like a naval cannon in appearance is a "gun" searchlight just perfected for use in a new form of sky-writing. Advertising matter inserted between the lenses in the barrel of the cannonlike projector is thrown in gigantic letters and pictures upon overhead clouds. The instrument was developed in the laboratories of the General Electric Company. The model shown above contains an eighteen-inch searchlight. Future models, with sixty-inch searchlights, may be able to hurl images upon clouds five miles distant

Black Death

By

FITZHUGH GREEN

A Naval Officer's Vivid Story Revealing Inside Workings of a Submarine

Illustrated by B. J. Rosenmeyer

THERE was a touch of mystery to the scene: two ships at a dead stop in the center of an otherwise empty ocean; weather clear as a bell; fresh breeze out of the north'rd; sea sparkling in the June morning sunshine and flecked with whitecaps. The kind of day when ships should be about their business.

These two weren't. Or, if they were, surely theirs was a very strange business.

One of the ships was a submarine, the U. S. S. *X-5*. To the lay eye she was merely one of those long, low black bodies, such as the ocean traveler grew so to fear during the war. But a Navy man at once would have spotted, forward of her conning tower, a curious bulbous growth.

On the bridge of the U. S. Naval Tender *Falcon*, the other vessel in the scene, the senior submarine officer of the American Navy was pointing to this bulbous growth and speaking with great earnestness:

"But it may mean death to thirty men, sir!"

Admiral Bowers, Chairman of the Secret Submarine Committee, bit nervously at his short white mustache. "Why do you say that, Commander Drake?"

"Because you can't cut a gaping hole in the top of a sub and install a movable cylinder as big as a boiler without weakening her structure!"

Drake's hands gripped the *Falcon's* screen rail until his knuckles showed white. Surely he was the embodiment of physical vigor. He stood, legs wide braced, sailor-wise, his stocky body swayed slightly forward so that his posture, as well as his strong chin and fine ruddy features, gave him almost an air of defiance.

A third man joined the two. He was a lean individual with an oversized head and pale face. His spectacles and stoop classed him as the academic type of man.

This was the famous Dr. Sigmund DeFrees, internationally known as an inventor and designer. The name DeFrees already belonged with those of immortals such as Edison and Diesel. Like Commander Drake, he had been selected from a long list of experts to face, in this secret test, the gravest crisis that had confronted the United States Navy since the declaration of war in 1917.

"Still worried?" inquired Dr. DeFrees affably.

Drake shrugged. "I'd hardly call it worry. After twenty years of submarines a man doesn't worry."

"Ah, but the practical operation of a submarine is so vastly removed from the fine points of its design." DeFrees' tone was both patronizing and genuinely amused. To him Commander Drake, for all his years of seafaring aboard submersibles, was but a highly trained chauffeur.

The inventor turned to Admiral Bowers. "The Secretary will be up for the first dive, won't he?"

As if in reply, there arrived on the bridge a judicial looking man with a kindly face, the civilian Secretary of the Navy. His presence at this secret test was token of the seriousness of the occasion.

"All ready, Commander Drake?" he asked.

"We're just waiting for the navigator to check our position, sir. Soon as we have the right depth Dr. DeFrees and I will go aboard the *X-5* and submerge."

"Just a preliminary test," put in Admiral Bowers. "We want to be sure Dr. DeFrees' cylinder fittings will stand the pressure."

THE admiral nodded toward the bulbous growth atop the *X-5*. This unnatural swelling was the upper end of the "DeFrees Releasing Turret," a device intended to make possible the escape of men trapped in a submarine at the bottom of the sea.

The invention consisted of a cylinder of steel about ten feet in diameter and six feet in vertical dimension, inserted into the upper body of the submarine. It had a small water-tight door near its floor and a hatch at its top. It was designed so that in emergency the crew of a submarine could take refuge in it and, after shutting themselves in, release it from the mother boat. Contained air would float it to the surface of the ocean.

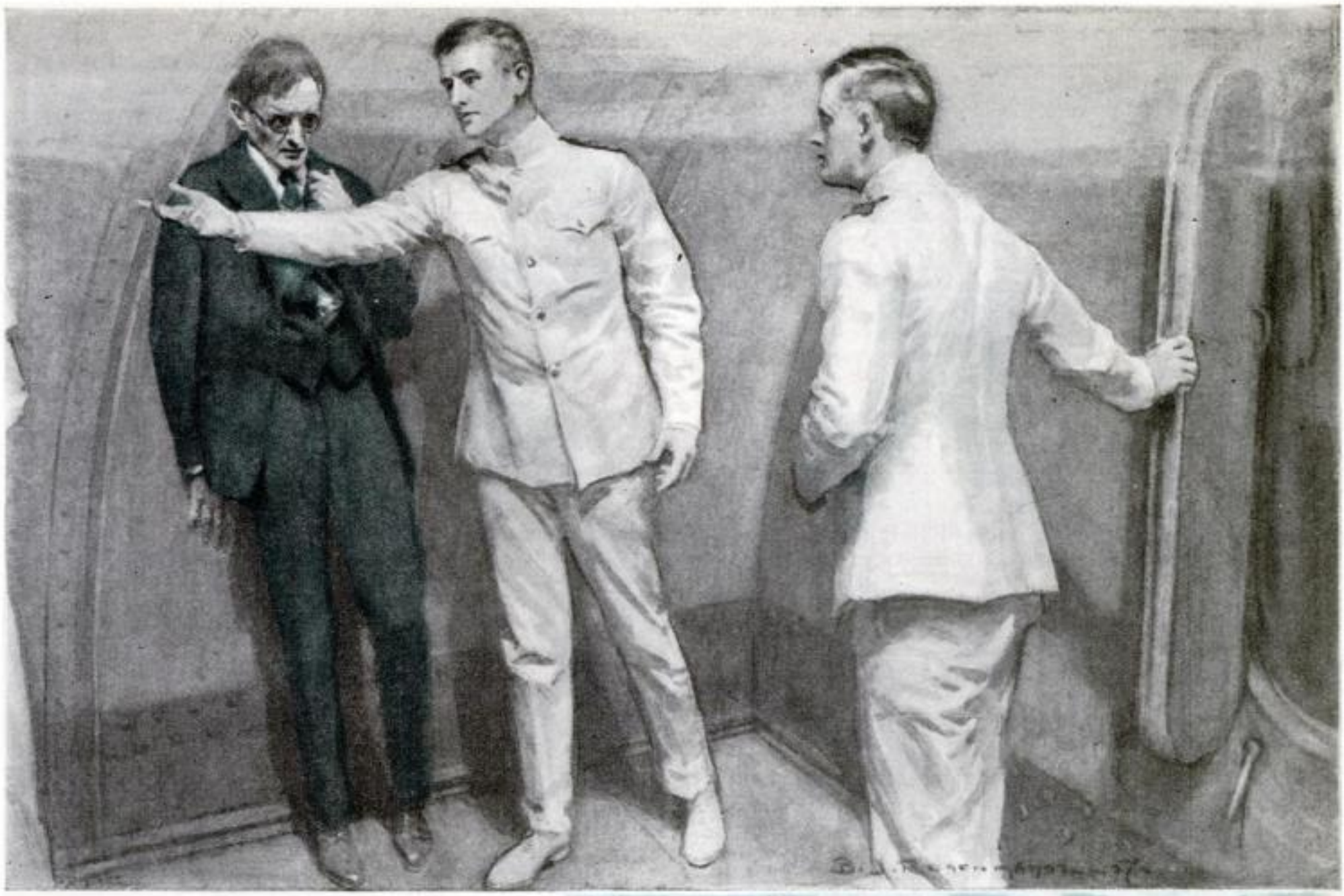
The Secretary questioned Drake: "You still doubt that this device will work?"

"I am willing to take a chance, if it will make submarines safer, sir. I believe, though—"

Dr. DeFrees interrupted: "He isn't taking a chance, Mr. Secretary," he said impatiently. "None of those men are."

"But you admit, doctor, that you have been down in a submarine only once or twice."

The inventor wrung his long-fingered hands. "But you don't understand, sir!" he cried. "As I have tried to drum into



Commander Drake faced the circle of haggard men whose doom lay in his hands. "Forget me," he said simply. "I'm in command. I'll stick with the old girl." There was a chorus of "Me too!" "You bet!"

Commander Drake's head, we can calculate the stress and strain on every element of a submarine's structure to the fraction of a pound!"

"But they still kill men," said Drake drily.

DeFrees' pale face reddened with anger. "Mr. Secretary, you know as well as I that the Navy has suffered six horrible submarine disasters this year! The people won't stand for this sort of thing much longer. Public opinion will force Congress to scrap every submarine you have. The President will not dare interfere!"

THE Secretary held up his hand. "We know all that. Congress has directed us to test your device because it looks promising. But we have brought Commander Drake all the way from the Pacific to handle the experimental boat because he is the best submarine officer we have."

"I don't doubt it," agreed Dr. DeFrees ironically.

"He has a picked volunteer crew on the *X-5* to take you down. If there is trouble—"

"Which there won't be," snapped DeFrees.

The *Falcon's* navigator stepped up to Admiral Bowers and saluted.

"We have reached the spot, sir."

The admiral glanced about the horizon where a cloudless sky met the blue sea. Hull-down northward were visible the disappearing masts of a vagrant schooner. A low haze in the west told where the land had faded out some hours before. Save for a sea gull or two and the black nubble of the *X-5* abeam, naught else was in sight.

"Here we are, Mr. Secretary."

"All right, Bowers, go ahead."

A flag shot to the *Falcon's* yardarm. While the *X-5* flickered aloft her answering pennant, the admiral added:

"We chose this spot, sir, because it has the necessary depth. We have just crossed the thirty-fathom line. That means we can keep our party private."

A few moments later the Secretary of the Navy warmly clasped the hands of Commander Drake and Dr. DeFrees, and the *Falcon's* whaleboat carried them to the *X-5*. On the low deck of the submarine a man trotted forward and disappeared through her torpedo hatch, closing it after him. Another swung shut the engine room hatch aft. A busy movement about the tiny bridge atop the conning tower at the center of the submersible soon resolved into a quick final housing of signal gear and other movable articles. A faint shout drifted across the intervening water.

Aboard the *X-5* all hands stood at quarters. Already Dr. DeFrees, grimy and slightly irascible, was below giving final touches to his invention.

"Stand by to submerge!" ordered Commander Drake crisply. Placing his lips to the voice tube in front of him he repeated the command, which was passed forward and aft. Men in the torpedo room at the bow sprang to their tubes, cocks and valves, to make sure they were tight. Those aft in the engine room stood by to shift propulsion. This last was necessary because the modern submarine is but a big steel torpedo propelled by oil engines on the surface and by electric motors drawing current from storage batteries when submerged. Oil engines need air that is not available under water. Hence the shift at diving.

"STAND by ballast tanks!"

Men at the admission valves prepared to let water flow into the big side chambers that run the length of every submersible and govern its buoyancy. Not only can these tanks be filled by opening valves and emptied by running heavy ejection

pumps, but automatic pumps keep the boat's balance by altering the amount of water ballast in them when men and material are moved forward or aft.

Receiving a report of "ready" from all operating stations, Drake directed his assistants to shift to the "control room." This is the inclosed space directly beneath a submarine's bridge in which are clustered the many intricate valves, wheels, gages, dials, bells, and other appurtenances vital to the operation of the boat. It is the operating room proper. From this point torpedoes may be fired, engines started and stopped, horizontal and vertical rudders manipulated, and every man in the crew reached at an instant's notice.

In the control room Commander Drake looked into the periscope, "the tube that sees around a corner," as it is sometimes called. At the upper end of this tube was a prism kept dry by a thin air blast. The prism bent light rays coming in, thus permitting the eye below to look about the sea's surface so long as the prism itself was above water.

"All clear?" queried Drake.

"Clear, sir, and ready!" snapped back Lieutenant Harboard, his second in command, a slender sunburned lad in his late twenties.

"Down rudder! *Tanks!*"

Instantly the *X-5* began to settle. Slowly her depth gage swung over: two fathoms—five fathoms—ten—twenty—

"Easy!" from Drake.

The helmsman "met her" with his horizontal rudder planes.

"Twenty-five," read the gage.

"Up rudder!"

"Thirty" lay under the gage arrow.

DRAKE thrust his lips to his tube. "*Pumps!*" he bellowed. "Stop flooding the main tanks! Begin ejection!"

He stepped back and wiped his forehead.

Harboard's head appeared through the water-tight door. "Thought this was a thirty-fathom spot, skipper," he said.

Drake glanced at the gage. It showed thirty-five fathoms!

"For the love of Pete!" he shot back. "That's what they told me! This must be a depression in the bottom. All we need is thirty to give the doctor's cylinder a test. Jump back and see what those hams are doing."

Harboard disappeared. But the depth gage did not move.

"Got up rudder on her?" Drake growled at the helmsmen.

"Yes, sir; full up rudder."

Still the depth gage did not move. To an old submarine officer like Drake this fact was ominous. He sprang through the door leading aft to the engine room, and crashed head-on into a machinist stripped to the waist.

"Oh, I'm sorry—" began Drake, helping the man to his feet. But the latter did not wait for him to finish.

Men staggered in the poisonous air, dragging the sub's engine forward section by section. Slowly the *X-5* was tilting upward

"*We're sinking, sir!*" The words rattled out in the high pitched falsetto of fear.

"Sinking—*how?*"

"Main—main battery room port—flooded—!"

Drake did not wait for more. He plunged across the narrow deck to the door leading forward. He hurdled through and landed with a splash on his feet in six inches of water.

There was no panic. But for a few minutes the *X-5's* main deck was a scene of swift action inspired by the common knowledge that pressure of the sea outside had sprung a seam leading to the flooded battery room, which in turn had, at the moment, an opening forward into the torpedo room and amidships into the main deck.

JUST as Drake had feared, the coring out of a large cylindrical space for the DeFrees turret had weakened the integral structure of the vessel. Theoretically, even the weakened seams should have withstood the pressure she had descended into. But it so happened that a heavy sea had caught the *X-5* at the moment she went under. In consequence she was rolling when she reached twenty fathoms. Thus to the terrific pressure of 120 tons of solid water above her was added a twisting movement which the theorist ashore in his study would not likely have anticipated.

As a result, a side plate that ordinarily would have been supported by a 'thwartships strut, removed to make room for the DeFrees turret, buckled under the thousands of pounds of pressure, and several of its rivets collapsed. Instantly tons of water rushed in before the horrified seamen had time to close water-tight doors and isolate the flooded space.

Drake quickly saw what had happened. A gleam in his eye showed his appreciation of quick action by two torpedo-gunners in getting the doors shut before the *X-5* was completely lost. Then he turned back to the control tower. Thirty men had placed their lives in his hands and he must not fail them.

Unexpectedly Dr. DeFrees blocked his way. In the excitement Drake had almost forgotten the inventor. Now he glared into the man's pale face.

It was easy to see that DeFrees was much shaken. His lips were colorless and his hands twisted nervously.

"A little leak?" he asked in a desperate effort to hide his fear behind facetiousness.

"Yes—sure," replied Drake mechanically. He brushed by the inventor and dashed back into the control room. Faces of the men he passed were tense. They, too, sensed the dreadful fact that at any moment the *X-5's* plates might crack again and admit another flood.

Even as Drake sprang through the water-tight door to his valves and switches the men had begun to gather in little helpless groups and whisper among themselves.

"*Black Death!*"

The Navy term for what happens when a submarine goes down and snuffs out the lives of her men. Would it enter the *X-5*?

Again Drake barked his commands.

"Main pumps on torpedo room! Full—ahead!"

He was a man clear through. But fear gripped him now; the kind of fear which, to the brave man, is a tonic for swift action and terrific effort.

SWEAT poured from the face of the machinist at the main clutch as he swung his lever over. Fear gripped him, too. But, unlike Drake, he was fully conscious of it. To him "Black Death" was a far more visible horror.

The pumps groaned and the engines spun until their oily packing began to smoke. But the depth gage pointer in front of Drake's staring eyes seemed glued at thirty-five fathoms. This depth was dangerously great. Weakened seams might start at any moment under the pressure and admit more water. The men would die before a rescue could possibly be organized above them.

"Stop!" rasped Drake. To Harboard he barked: "Get all hands but those at pumps and switches. Sally ship!"

"Aye aye, sir!" Harboard mustered the men into a "sally ship" gang. Under his sharp orders this party ran back and forth across the main deck in a frantic effort to shake the *X-5* loose, while Drake operated the controls.

For twenty minutes the feverish struggle went

Dr. DeFrees' face reddened with anger. "He isn't taking a chance, Mr. Secretary," exclaimed the inventor. "None of those men are."

on. The sailors, who first had choked jests from their taut lips to show defiance of a ghastly death, now compressed those same lips into thin and silent lines. Pound of the pumps and engine resounded throughout the hull, broken now and then by Drake's sharp urgings and Harboard's rhythmic "*Starboard! Port! Starboard! Port!*"

Their efforts were futile. "Hold everything!" cried Drake.

The engine room had become a sweltering prison, almost unlivable from the thick smoke of overheated lubricating oil.

"Harboard, man the oscillator! Don't let the operator be stupid. Tell the *Falcon* we're down and stuck here. Make it snappy!"

"Aye aye, sir."

THE panting crew propped themselves against the *X-5's* clammy bulkheads while the junior officer hurried forward to the electric vibrator which could shoot sound waves under water to a receiving diaphragm in the outer skin of the *Falcon*.

Two minutes later he was back facing Drake.

"Oscillator flooded, skipper," he said.

"It can't be!"

"It is, skipper."

For a moment Drake buried his face in his hands. "You know," he said, "there's no rescue craft closer than New York."

Harboard nodded.

"And the only pontoon unit on this coast is at Boston. So if we can't signal to the *Falcon* nothing will start toward us today."

To both men, after many years of service in the "eggs," their plight was plain. Long before drags could locate the *X-5* those in her, if they had not drowned, would have gasped their last anguished breath. The *Falcon* was helpless. So far as she was concerned, when her oscillator failed to rouse the submarine the admiral and his companions could come to any conclusion: for all they knew, the *X-5* might already hold the lifeless bodies of her crew. Her silence might mean anything from an explosion to a ruptured seam.

Drake stepped to Harboard's side. "We mustn't weaken, old man. Those lads out there are scared stiff already."

"So am I," said Harboard frankly.

Drake forced a smile. "Remember that the boss of the whole works is up there on the *Falcon*. The Secretary can move any ship in the Navy. He'll stick right by us. The weather is fine."

"I know, skipper, but —."

In the doorway stood Dr. DeFrees! His ashen face twitched, as he fought to conceal the terror that had already drenched his garments with cold sweat.

"Guess—we'd better—try my cylinder," he stammered.

"Can you beat it!" exclaimed Drake. "Honestly, doctor, in all the excitement I hadn't even thought of it!"

"But there isn't any other way, is there?"

"Not that I know of. We're flooded down forward. Our pumps can't handle such pressure. We're down too deep to send a man up through our torpedo tube even if we could get to the torpedo room. We haven't enough ballast to change her trim. We can't communicate with the *Falcon*. All we can do is sit here."

"Well, why not use my cylinder?" repeated the inventor weakly. "We came out here for that very thing, didn't we?"

Not a trace of the patronizing air and condescension he had shown toward Drake on the *Falcon* was left in his manner. Rather was he like a frightened child who begs assurance and comfort from the older and more experienced parent.

"All right, let's see," said Drake with a touch of irritation. One could not blame him, since it was the doctor's "Releasing Turret" that was to blame for the *X-5's* predicament.

Out in the main country abaft the control room were gathered the crew. They knew the pumps had refused to work. Sallying hadn't budged the *X-5*. As a seafaring vessel she was deaf, dumb and blind. They knew it meant they might have to die there on the floor of the sea. They were brave men. But it is one thing to face death in the heat of action; another to face it in the ghastly silence and inaction of a sunken submarine.

As Commander Drake entered he was surrounded by a circle of silent but beseeching seamen whose doom lay in his hands. He alone could save them. Already the air was thick with smoke and the sharp bite of chlorine gas from the batteries.

DRAKE spoke briefly: "Men, you know that Dr. DeFrees invented the cylinder here behind me. You can enter this cylinder by its hatch—" indicating with his hand. "Then it can be released from us. Contained air will float it to the surface with those inside. This cylinder is not big enough to take all. Those of you who want to risk it can draw lots. The lucky ones can go."

The chief machinist stepped forward. "That's all right, captain. But what do you think about the safety of this blooming thing?"

Drake shrugged. "I don't know much about it, chief. Frankly, I have my doubts whether it will stand the water pressure when it lets go."

DeFrees clicked his tongue angrily, but none heeded him.

"Will you draw too, captain?" the chief went on.

Drake shook his head. "Forget me," he said simply. "I'm in command. So I'll stick with the old girl."

There was no vain glory in the quiet words, no effort at dramatic renunciation. Just a plain statement of fact. But their effect upon the men was electric. Instantly rose a chorus of "*Me too!*" "*You bet!*"

(Continued on page 131)

Car Makes 207 Miles an Hour

Giant 1,000-H.P. Auto Demonstrates New Racing Principles

By H. C. DAVIS

To spectators of Major Segrave's spectacular run over the sands of Daytona Beach, Fla., in the *Mystery S*, the roaring car was merely a blur of red, gone in an instant. Nothing like its speed has ever been made by man on land

The victorious pilot, wind-blistered and with wrists lamed from holding the machine to its course, being carried away by admirers after the race

"I WAS going so fast I couldn't look at the speedometer! To guide the car, I had to focus my eyes half a mile ahead. If I had looked at the dial for an instant I might have lost control. I didn't know the car had made 200 until after the run."

The British speed king, Major H. O. D. Segrave, was describing his recent experience in driving his mammoth Sunbeam racer, the *Mystery S*, over the sands of Daytona Beach, Fla., for a world's record of 207.01 miles an hour. If you can imagine an automobile covering a city block in less than a second, you may conceive—possibly—of such terrific speed.

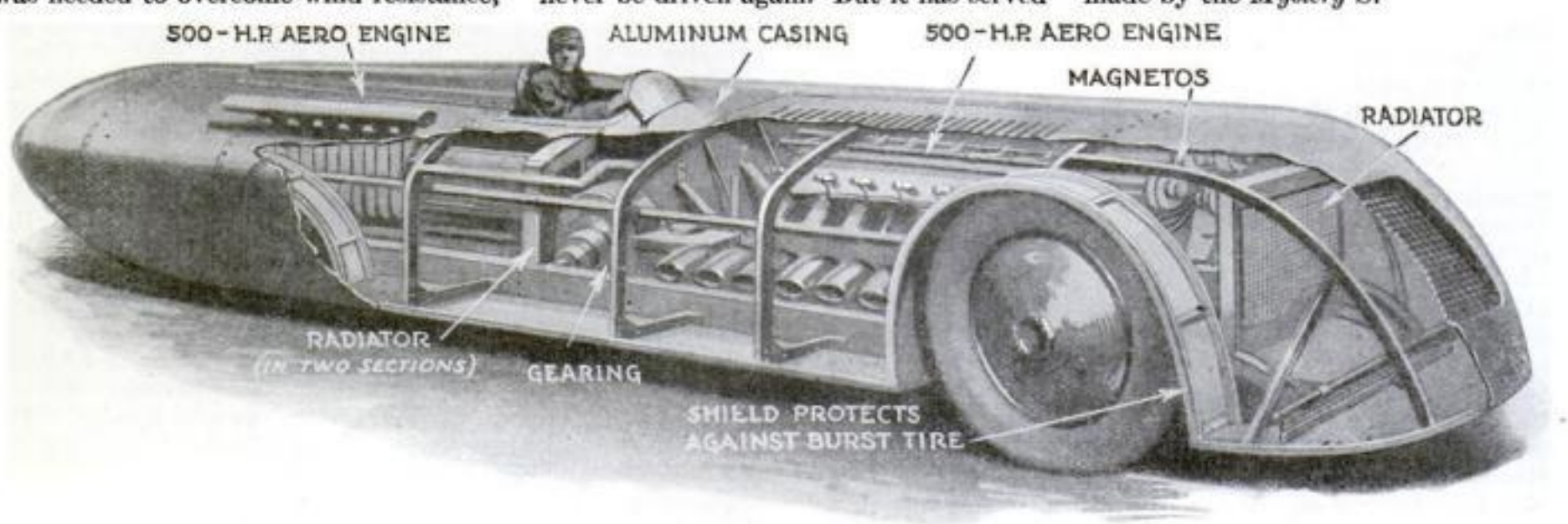
The real marvel of the *Mystery S*, however, is not the record itself but the marvelous way science overcame the mechanical problems presented by the demands of unprecedented speed—chiefly, the conquest of wind resistance through its immense power plant and its body design.

Wind resistance, of course, increases in far greater ratio than the increase of speed; to double speed requires an engine not twice as powerful but eight times as powerful. Segrave's car was driven by two twelve-cylinder engines, each developing 500 horsepower. About half of this power was needed to overcome wind resistance, which at 200 miles an hour amounted to almost half a ton! To the same end, the wheels of the car were hidden under a smooth, blunt-nosed body of radically different design. This projected the air upward instead of against the wheels and axles as in the conventional type of speed car with pointed radiator. The pilot's head was the only object exposed.

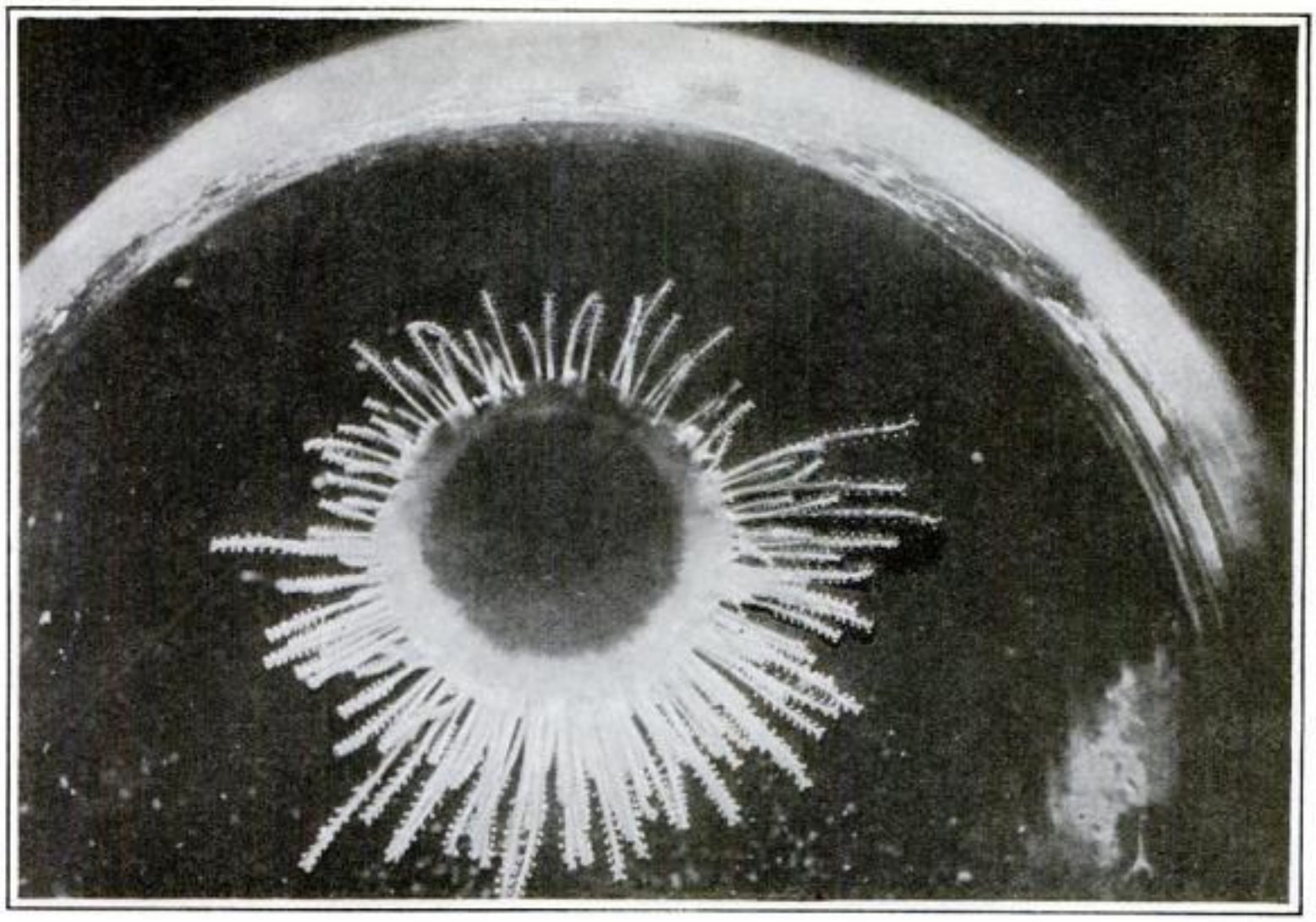
Tires, too, played a vital part. The builders spent eighteen months developing tires that would last for three minutes at 200 miles an hour. If a tire had blown out, the pilot would probably have been killed instantly.

It is a freak car, and Segrave says it will never be driven again. But it has served its purpose. Besides demonstrating that the present orthodox design of motor car can make 200 miles an hour, it has shown where improvements must be made. The present design of brakes, for example, proved wholly unsatisfactory, the terrific heat generated causing the metal to melt.

Segrave's record is the fastest man has traveled on land. The steam locomotive record is 120 miles an hour. The airplane record is 278—not so far ahead of Segrave's 207! Will man ever travel faster on land than that? The British visitors predicted that within eighteen months an American manufacturer would build a car that would break the record made by the *Mystery S*.



The marvelous mechanism of the *Mystery S*. The car is capable of 65 m.p.h. in first speed, 175 in second and 207 in third. The two engines, back and front, must be synchronized before the main clutch can be used, and if they are not operating at the same speed the car will be wrecked



This luminous jellyfish, found in the Sargasso Sea, is one of thousands of creatures that illuminate the ocean. The beautiful corona, or halo, is thrown by its own living light

Science Reveals

Secrets of "Cold Light"

Studies of Luminous Insects, Fish and Bacteria May Yield Key to More Efficient Lighting of Our Homes

By ELLSWORTH BENNETT

SCIENTISTS are on the verge of far-reaching discoveries which eventually may make the incandescent electric light as out-of-date as the old-fashioned kerosene lamp. They are learning the secrets of a lighting system used by Nature for ages, yet always a mystery to man—the production of light without heat.

In a laboratory at Princeton University, Dr. E. Newton Harvey, professor of physiology, recently utilized the materials employed by fireflies in the summer to flash their lamps, and by fishes in the seas' depths to light their lanterns to produce continuous "cold light." Doctor Harvey believes that science will be able soon to create these materials artificially.

At the United States Bureau of Standards in Washington, two other scientists, Dr. W. W. Coblentz and Dr. C. W. Hughes, have just succeeded in analyzing and recording the intensity of the light emitted by various luminous animals and plants. By studying the spectrum—that is, by dividing the light into the rainbow of various colors, or wave lengths, that compose it, they have demonstrated that this "living light" is virtually a hundred percent efficient in its radiation. In comparison, our best electric lamps, wonderful as they are, are woefully wasteful. In the laboratories of some of the larger electrical companies, still other experimenters have made lifeless substances glow without heat under strange invisible rays.

Since the beginning of time men have produced light by heat, by burning substances such as wood, tallow, oil or gas. The higher the temperature, the brighter the light. In the modern electric lamp we use electrical energy to heat a metal filament to the highest possible temperature and make it glow.

The incandescent lamp, marvelous invention though it is, shares with every other form of hot light the drawback that most of its radiation is in the form of heat, and not light at all. Less than two percent of it is visible light. The rest is wasted for the reason that the heat cannot be separated from the light.

Luminescence, or living light, on the other hand, contains nothing but visible light, as Doctor Coblentz's experiments have proved. The firefly's light is all light. It is fifty times as efficient in light radiation as the finest incandescent lamp!

The glow of living creatures is only one of several different kinds of cold light, produced in widely different ways. Place your hand under a strong electric lamp, and your skin and finger nails will give off a glow. This glow is not reflected light, but is actually produced in the skin and nails. If the lamp light can be screened from view, the strange glow will become visible. Your hair, teeth, eyes, or almost any other part of your body can be made to give off similar light. This is fluorescence. It is explained by the theory that the body tissue has the mysterious faculty of converting rays of one wave length into rays of another wave length.

LIGHT, as we commonly know it, is simply the part of radiant energy visible to our eyes. In common with radio, X-rays, ultra-violet rays and other forms of radiation, it consists of ether vibrations, or waves. The differences between all of these lies simply in the length of their waves. Thus, the wave lengths of

ultra-violet rays and X-rays, for example, are shorter than those of visible light, while heat waves and radio waves are longer. The different colors of the rainbow vary in wave length, too, from the shortest waves of violet to the longest waves of red.

USUALLY, in fluorescence, short wave lengths are converted into longer wave lengths. Thus, many substances, including silk, wool, bone, horn, and numerous kinds of living matter, have the ability toconvert invisible ultra-violet light, which has extremely short wave lengths, into visible fluorescent light.

Dr. R. W. Wood, of Johns Hopkins University, Baltimore, recently gave a spectacular demonstration of this kind of fluorescence. He directed ultra-violet rays from a filter lamp into a vessel containing aesculin, a substance extracted from the bark of the horse-chestnut tree. Immediately the solution shone with brilliant greenish-blue light. So vivid was its illumination that a photographer, by its light, was able to take the picture of Doctor Wood reproduced here. Other substances exposed to the rays produced glows of varying tints.

In somewhat similar fashion Dr. W. D. Coolidge, of the General Electric Company, inventor of the improved cathode ray tube, has made rocks, crystals and other substances glow with beautiful lights after exposure to cathode rays, produced by streams of electrons.

Sometimes substances will continue to give off fluorescent light after they have been removed from the "exciting" light. In certain cases they continue to glow for hours. This persistent light is called phosphorescence.

A faint cold light may be produced by rubbing two lumps of sugar together so as to crush the sugar crystals. A similar light appears if you shake crystals of uranium nitrate in a tube. Every time the crystals hit each other a little flash of light is produced. This is called triboluminescence. Again, if you take a roll of electrician's adhesive tape and rapidly strip off the tape, a faint glow will appear at the instant the tape breaks away. The light is believed to be caused by the rubbing together of minute crystals on the tape.

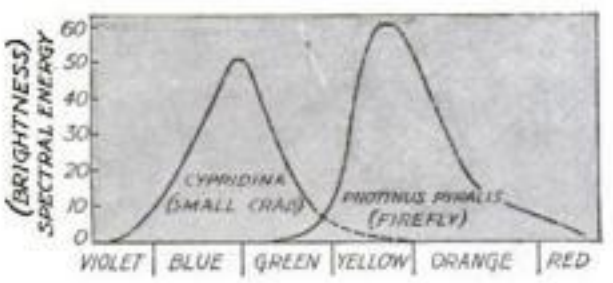
Certain chemical mixtures, too, produce heatless light. Thus, if to pyrogallic acid—the familiar "pyro" used by photographers in developing negatives—you add hydrogen peroxide and a small quantity of potato juice or animal blood, the mixture will become luminous. This is known as chemiluminescence.

BUT it is in "living light" produced by animals and plants that scientists see the greatest possibilities for future usefulness. Some of these luminous creatures use lamps ingenious almost beyond belief.

In Doctor Harvey's laboratory at Princeton you can see a glass jar half filled with small grayish crumbs resembling birdseed. Once these crumbs were tiny crablike creatures called *Cypridina* living in sea water near Japan. They carried little lighting plants in their bodies which made them glow. Now they are dead and dried. Yet today these dry crumbs, moistened with water, immediately give flashes of bluish-green light! There is no burning; no heat. The strange source of light seemingly is undying.

On the earth, in the sky, and in the sea are countless other living things that manufacture light. Passengers on ocean liners often see the sea apparently burst into a vivid glow when stirred by the passing ship. This light, commonly called phosphorescence, comes from millions of light-making animals, most of them so small that they can be seen only with a microscope. And in the depths of the ocean are strange fishes that dangle gleaming lanterns from long stalks projecting from their heads; others with rows of lights along their sides, like a ship with lighted portholes.

The only light used in taking this remarkable picture was the greenish-blue glow from a substance in horse-chestnut tree bark when exposed to ultra-violet rays. The photograph shows Dr. Robert W. Wood, physicist, of Johns Hopkins University, one of the scientists seeking to copy Nature's methods of light production



Spectrum chart, showing two typical luminous creatures a hundred percent efficient in light radiation. All of their radiation is in the visible part of the spectrum; in other words, none of their rays are lost in heat beyond the red end, nor in invisible rays beyond the violet end

In the waters of Japan lives a squid that brandishes lamps on the ends of its tentacles. As it swims it waves these lanterns, flashing them on and off. The Japanese call it the "hotaru-ika" or "firefly squid." Living in perpetual darkness in the depths of the Mediterranean is another squid which, when danger threatens, squirts a luminous substance into the sea water.

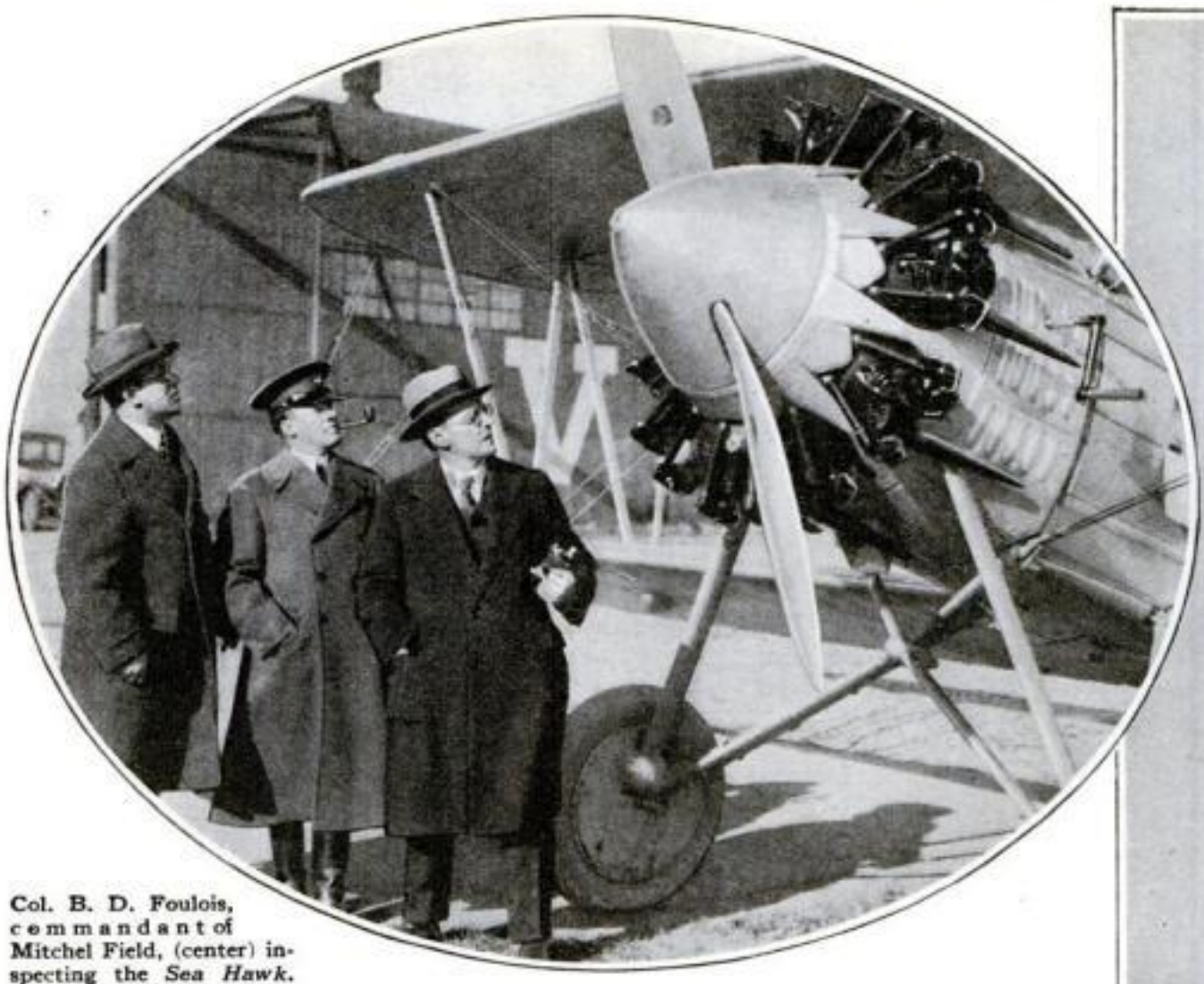
THERE are marine worms that turn on their lamps when attacked; luminous sponges, jellyfish, earthworms, centipedes, starfish, glowworms, shrimps, crabs and many others. They number tens of thousands. In all, at least forty orders of animals include one or more forms capable of producing cold light.

A large number of deep-sea fishes are equipped with lamps that resemble surprisingly man-made searchlights. There is a double convex lens for directing the light in a beam. Back of the lens is a layer of cells containing shiny material which acts as a reflector. The light, produced in the center of the organ, is thrown against the reflector which shoots it out through the lens in a concentrated beam. And some of these light-producing organs are fitted with color filters which allow only light of certain wave lengths to pass, thus producing a definite color. One deep-sea cuttlefish, for example, possesses luminous organs of at least three different colors—blue, violet, and reddish. A certain South American insect, called the automobile bug, conveniently enough has a white light at its head and a red light at its tail.

The plant world, too, contains at least two light-making forms. No doubt you have seen damp wood glow at night. This "fox fire" is produced entirely by fungus in the wood. Or perhaps you have seen meat or fish in a refrigerator glow in the dark. This faint light comes from microscopic luminous bacteria. The fungus and bacteria both are plants.

Oddly enough, the bacteria, smallest lamps in the world, have proved the most useful in the study of living light. Bacteria give off light continuously, and colonies of them can be kept alive indefinitely. Doctor Harvey not only has measured the intensity of their light, but actually has computed the efficiency of their lighting mechanism. And this despite the fact that the bacteria are so small that 25,000 of them, placed side by side, would barely fill an inch. The light of a single one of them cannot be seen even under a microscope. Only when thousands are together is their illumination visible. It takes 50,000,000,000,000 of them to equal one candlepower of illumination.

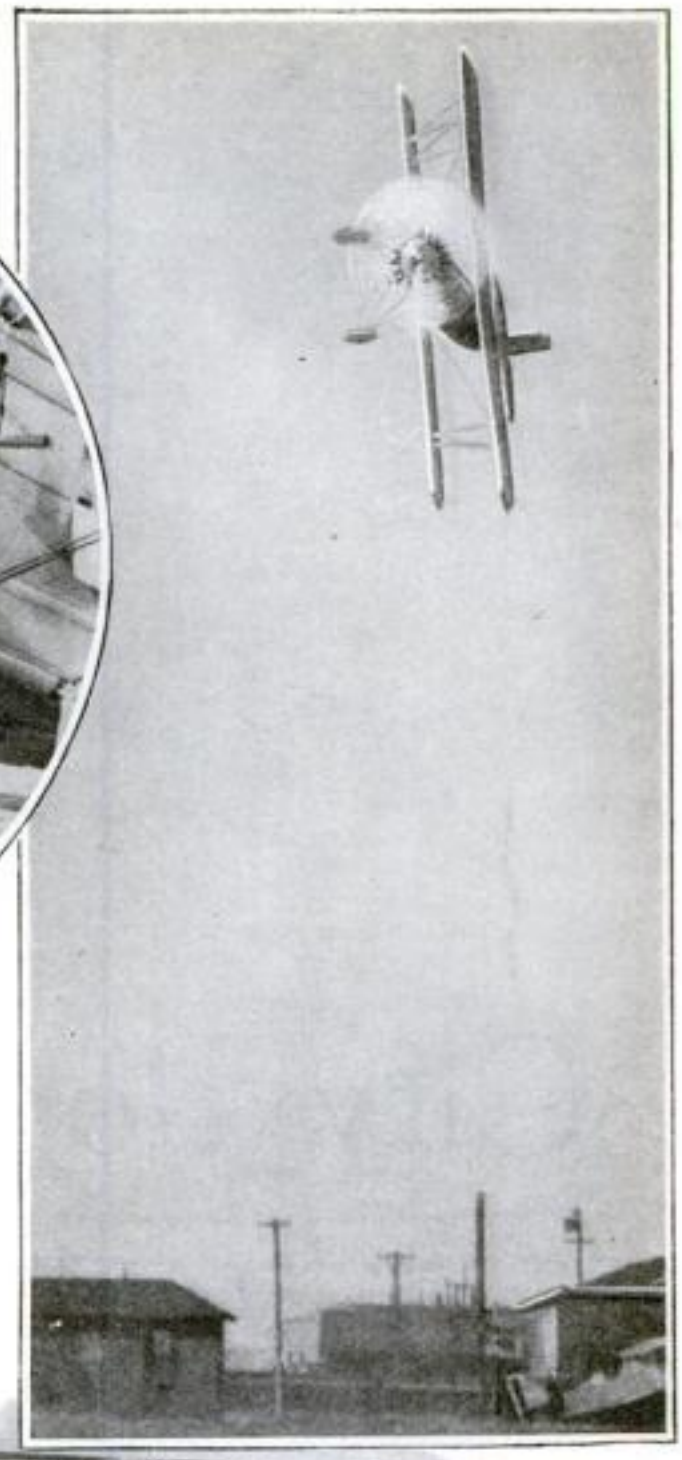
DOCTOR Harvey measures their light by making an emulsion of billions of the bacteria in sea water. Then he counts the number in each cubic centimeter, measures the light emitted by one cubic centimeter, computes the light which they absorb from one another and so calculates the light which each individual would send in all directions if there were no absorption. By measuring the food and oxygen consumed by the bacteria in relation to the amount of light energy produced, he estimates their over-all efficiency as (Continued on page 138)

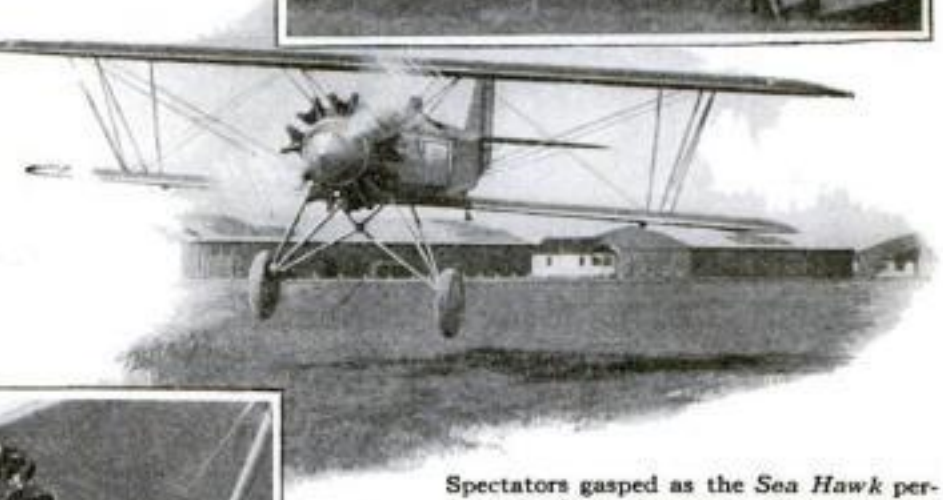


Col. B. D. Foulois, commandant of Mitchel Field, (center) inspecting the *Sea Hawk*. Its nine-cylinder engine is of the air-cooled type

New Plane Stops Like an Auto

"Sea Hawk" *Rivals the Birds in Speed Range and Control*





Spectators gasped as the *Sea Hawk* performed these dangerous feats. Upper photo, "standing on a wing tip" while making a turn. Lower photo, touching wheels to ground and rising in air again

ONLY six feet of air separate the plane from the ground. Motor roaring, it flirts with the earth. Gracefully, lazily, it skims closer, throttled so slow that a fast motor car could outdistance it. It touches—rises again, wheels spinning from the contact—and airily circles the field. Now it lands. Rather, it "sits down." Instead of bumping for many yards along the ground, it glides to earth and stops within a few feet!

This was the first public test, the other day at Mitchel Field, N. Y., of a remarkable new fighting airplane, the *Sea Hawk*, built for the U. S. Navy. The plane's ease of maneuvering at slow speed and its hydraulic wheel brakes indicated that it could land directly upon the deck of an airplane carrier.

Yet when its 425-horsepower motor is opened up, the plane achieves a speed of 170 miles an hour. The *Sea Hawk* is called the fastest plane in the world equipped with an air-cooled motor.

Embodied in its construction are a thrust-back lower wing, enabling the pilot to see his landing gear; shock absorbers; staggered wing construction; and curved upper wing, to avert danger of the deadly tail spin. It can be converted in a few minutes into a seaplane by the addition of pontoons. Under the cowling are two machine guns, which fire through the propeller. Neat lettering on various compartments along the fuselage show the location of the engine crank, log book, fire extinguisher and tools.

T. N. Joyce, test pilot, and the new plane. The wheels are equipped with hydraulic brakes, operated as in an automobile. It also has shock absorbers

Novel safety devices—features usually sacrificed to speed and maneuverability in fighting planes—are provided. A button in the cockpit, in case of fire, squirts extinguisher fluid on the engine. A valve empties the gasoline tanks into the sea in an instant. And a rubber lifeboat is within reach of the pilot, provided with bottles of liquefied carbon dioxide gas that inflates it in six seconds, and small oars for paddling, if the plane should fall into the ocean!

The pairs of figures above indicate by their comparative sizes the populations that will be supported eventually by different regions. North America will support 600,000,000, of whom 200,000,000 will be in the United States. The equatorial regions will be densest

City Populations Predicted *from* Study *of* Flies

Experiments with Pumpkins, Yeast and Rats Make Possible Forecasts of Cities' Growths

By MYRON M. STEARNS

THEY were weighing a rat in one of the research laboratories of Johns Hopkins University at Baltimore. Weighing it with particular care, for a strange reason—to find out what the population of New York City would be in 2000 A.D.!

The study of a rat's growth came in the course of an investigation by Dr. Raymond Pearl, Director of the Institute of Biological Research, at Johns Hopkins, by means of which he has demonstrated that the increase in population in a given region or country over a particular period of time can be foretold with almost unbelievable accuracy.

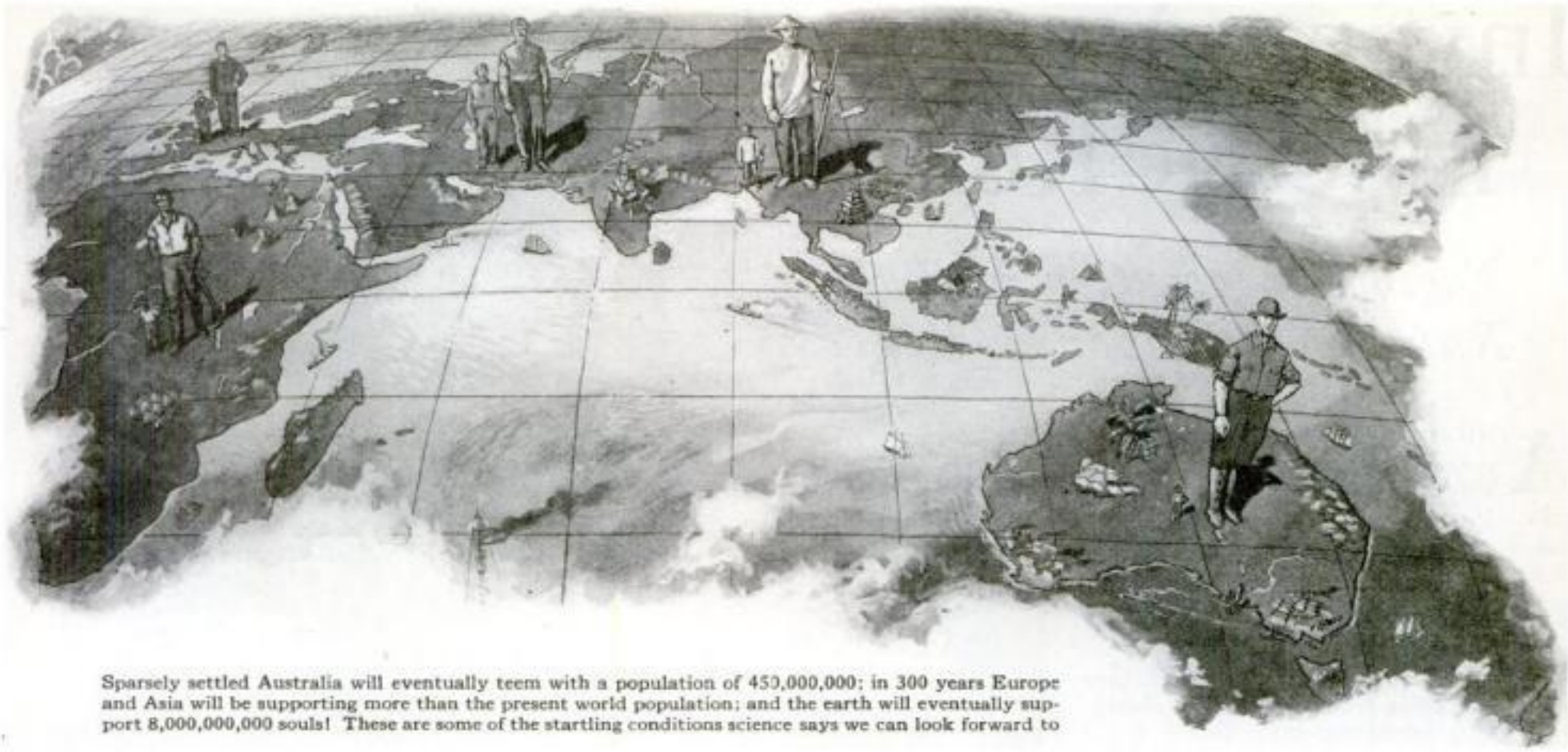
For seven years Dr. Pearl has been studying population growth. The first observations were made with a pumpkin, which like all other living multicellular organisms, grows by the division and reduplication of its cells. A single cell reaches the limit of its size, then splits across the middle and becomes two cells. At first it looks as though the process could go on forever, with the pumpkin getting bigger and bigger. But Dr. Pearl discovered that at first the pumpkin grows rather slowly. Then the rate of increase becomes much more rapid. Finally, after it reaches maximum speed, it begins to slow down again, the slowing-down rate almost exactly reversing the acceleration. The division of cells becomes less frequent, until the pumpkin, reaching full size, stops growing.

The investigation shifted to the tail of a tadpole. If a tadpole loses its tail, it promptly grows a new one. Doctor Pearl wondered if the growth of a new tail, speeded up by Nature to meet the emergency, was similar to the normal growth of a pumpkin.

They found it was. As in the case of the pumpkin, the new tadpole tail began to grow slowly. Then the rate rapidly increased, the single cells that composed it dividing faster and faster, until a maximum rate of growth was reached. After that the process slowed down as the tail approached full size, and then stopped altogether.

THEN there was the rat—and again the growth tallied with those of the pumpkin and the tadpole's tail. Rat, pumpkin, and tadpole tail, however, all differ in one respect from any growth resembling that of population. The new cells remain with the old cells to form a single whole—the whole rat or the whole pumpkin. But Dr. Pearl was endeavoring to trace a similarity between the growth of the rat, the pumpkin and the tadpole tail in an effort to establish that the seemingly haphazard increase in the number of people in the world in reality follows similar fixed laws. To come a step nearer to the growth of a human population, an experiment was next tried with fruit flies—multicellular organisms that can fairly be compared with a human population in their independence of action and response to environment.

TWO fruit flies were put into a half-pint bottle with a quantity of banana-agar—a gelatinous food supply sufficient to nourish a whole fruit-fly army. The female laid her eggs, the eggs hatched, and soon the bottle was teeming with population. Regular counts were taken, to note the rate of increase. As the population grew, the rate of increase grew with it. Then, with the bottle becoming too crowded, the increase slowed down and finally stopped altogether. The fruit-fly world embodied in the half-pint bottle had all the population



Sparsely settled Australia will eventually teem with a population of 450,000,000; in 300 years Europe and Asia will be supporting more than the present world population; and the earth will eventually support 8,000,000,000 souls! These are some of the startling conditions science says we can look forward to

it had space for. Only enough flies were hatched to take the place of those that died. The law of growth had operated exactly as with the rat, the pumpkin and the tadpole's tail. A similar experiment was made with yeast, with like results.

THEN came the final step: to apply the results of these experiments to actual human conditions. And since, obviously, no experiment with humans could be made in a single lifetime, it meant turning to history; to Sweden, where population figures have been recorded since 1750. Sweden's population growth during that time was compared with the population of the fruit flies in the half-pint bottle. Setting the Swedish census figures for each decade, from 1750 to 1920, down on a chart, a curve was shown almost identical with that of the experimental fly population! The scientists made calculations from the laws of growth that they had found applicable to the cells of the pumpkin, the tadpole's tail, the rat, the yeast, and the fruit flies—and it worked just as well for Sweden. Mathematically, according to the law they worked out, the Swedish population for 1800 would be 2,302,000. The actual figure for Sweden in 1800 was 2,347,000. For 1830 the calculations gave 2,900,000. Sweden's actual population in 1830 was 2,888,000. The calculation for 1920 was 5,876,000, while the last Swedish census in 1920 gave 5,904,000.

They worked out figures for the United States, where the population has been known, with comparative accuracy at least, since 1790. Another striking corroboration of the law of growth was obtained. The parallel was as close as that of Sweden. For 1800, for example, the calculations showed the United States population, according to the law of growth, would be 5,336,000 people. As a matter of fact, it was 5,308,000. For 1900 the calculated figure was 76,870,000 while the census count was nearly a million less—75,995,000. That was just after the Spanish War. But by 1910 the two sets of figures had come together again: 91,972,000 calculated and by census 91,972,000.

Thus any country's future growth curve can be worked out from the figures of its present and past growth already known. In France, for instance, the census figures show her population increase slowing up just as the fruit flies did in the bottle after the population had approached its maximum. The United States, on the other hand, is shown to be only a little past the middle of its era of expansion. According to the growth-law figures, our population will be 184,678,000 at the end of this century, with the "saturation point" reached a hundred years later, just inside the 200,000,000 mark.

With all such calculations, however, one important thing must be borne in mind. They are all based on the assumption that the general conditions affecting population growth remain the same—just as the conditions for the fruit-fly experiment remained the same. Conditions affecting the Swedish population have remained practically unchanged since 1750. In exactly the same way the population of the United States has developed strictly in accordance with the law of growth for more than a century.

INCIDENTALLY, it is interesting that the tremendous immigration into the United States during the last century did not affect the law-of-growth figures appreciably. According to the law that Dr. Pearl and his associates have worked out, a country will fill up with population under a certain set of conditions just so rapidly, and it makes little difference whether the increase is by birth and natural growth or in part from immigration. Wars, even, make little difference, unless food supplies or economic conditions are permanently affected. For a decade or two the population figures vary a little as the result of such an upheaval as, for instance, our Civil War—then the normal growth is resumed, practically unchanged.

In Europe another scientist, Professor Albert Penck, has submitted to the Prussian Academy his belief that dense populations of the future will move to the tropics. He estimates that in place of the present world

(Continued on page 140)

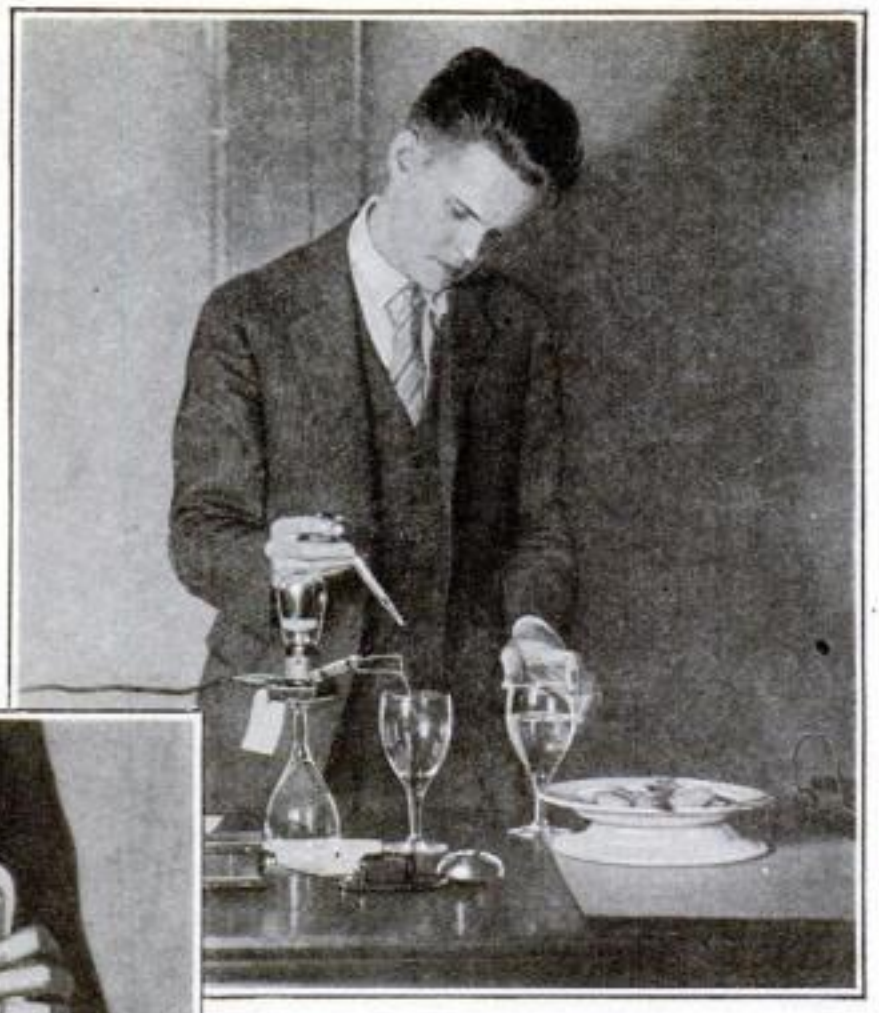
How Your City Will Grow

IT IS possible, taking Dr. Pearl's "law of growth" as a basis, to predict accurately the populations of American cities by the end of the century. The following figures show how eleven leading cities will rank seventy-three years from now—the shifting of Detroit and Los Angeles to third and fourth places being among the most interesting changes:

	1920	2000 A. D.
New York City	5,731,000	13,948,000
Chicago	2,701,705	5,400,000
Detroit	993,678	4,750,000
Los Angeles	576,673	4,125,000
Philadelphia	1,823,779	3,575,000
Baltimore	733,826	1,725,000
St. Louis	772,897	1,556,000
Boston	748,064	1,450,000
Seattle	315,312	1,175,000
San Francisco	506,676	1,141,000
Pittsburgh	588,343	893,000

Invents Amazing Electric Relay

Engineer's New Control Tube Runs on a Billionth-Watt



Below, the "grid-glow" relay, most sensitive electric control ever devised; and, right, D. D. Knowles, its inventor

When a drop of water fell upon two wires extending from the bulb, an electric bell sounded

A GOLD watch lay on a plush-covered table in a New York hotel. Near by was a small glass bulb. A man extended his hand to the watch; but even before he could touch it, an electric alarm rang.

A lighted match was held between the thin wires connected with the bulb. The bell rang again. The same thing happened when a drop of water fell on the wires, and again, when the window shade was raised, admitting sunlight!

These magical happenings were demonstrations of a new relay instrument, said to be the most sensitive of its kind ever made, the invention of D. D. Knowles, 28-year-old engineer of the Westinghouse Electric and Manufacturing Company. A relay is a device that controls a large electric current by a much smaller one. The Knowles "grid-glow" will respond to a billionth of a watt, or one fortieth the energy exerted by a fly climbing an inch up the wall! It can magnify electric power a hundred million times, compared with the ten thousand times of the ordinary relay.

While its chief use will be in the automatic control of electric machinery and devices, the relay can also be used to turn lights on and off automatically; to count people, automobiles or products passing a given point; and to protect valuable exhibits in stores and museums.

The bulb is gas-filled and, like a radio tube, contains two electric poles and a grid, though no filament. The poles are connected in the circuit to be controlled. Between them the charged grid acts as a gateway or blockade against the flow of current. When some minute outside influence, such as the movement of the hand in reaching for the watch, draws the charge from the grid, the gateway opens and the current flows, operating the bell.

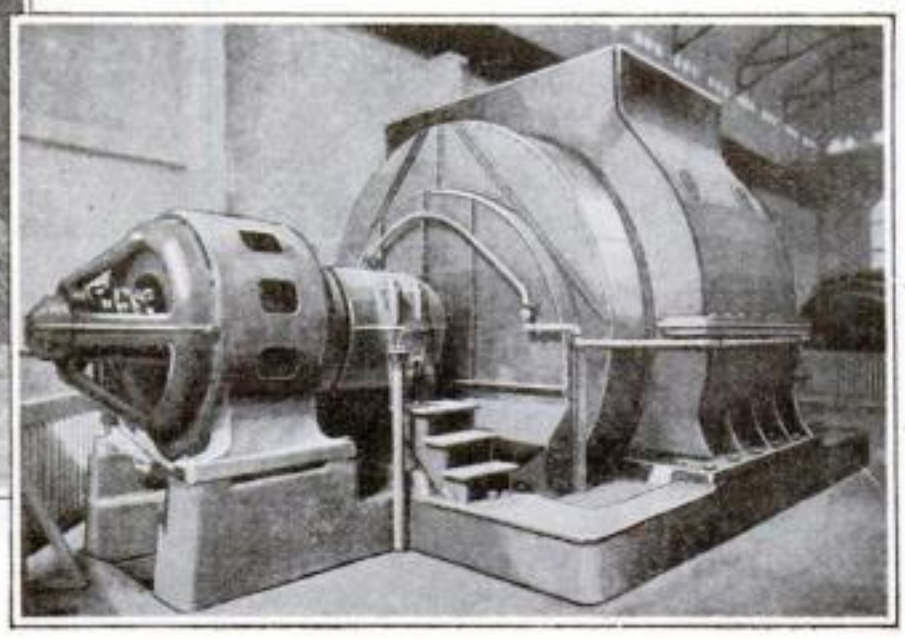
Longest Power Transmission Near

Frank G. Baum, San Francisco engineer, whose rotary synchronous regulator, or condenser, is hailed as "one of the most important inventions ever made in the handling of electricity"; at right, a photo of the apparatus

CHEAPER electricity for all of us, because it can be transmitted economically thousands of miles where only hundreds have heretofore been possible, may be one of the results of a new system of handling electricity perfected by Frank G. Baum, San Francisco engineer. By it, electric power generated in the Rocky mountains can be sent to the Mississippi valley or even farther east, and the power of Niagara can span the country.

Mr. Baum's invention comprises a rotating synchronizing regulator. His system divides the entire transmission line into sections of 100 to 200 miles, linked by the rotary regulators, or condensers, each of which transmits the current onward with small losses.

The new invention promises to make possible the utilization of waterfalls which are now idle because they are in isolated localities; for example, the great falls in the center of Africa, in South America, in Labrador and elsewhere.



Forty-Niners *of* 1927

Motor Cars, Airplanes and Modern Machinery Mark Latest Stampede for Gold in Nevada

By EDWIN KETCHUM

EARLY this spring two nineteen-year-old boys, prospecting in the barren hills of Esmeralda county, southwestern Nevada, ran upon a badger hole. They dug into the hole. At the bottom, instead of a badger, they found a ledge of rocks shot with streaks of gold. The boys staked a claim and carried samples to Tonopah, thirty miles away. The rock assayed enormously rich—$78,000 a ton!

That was the beginning of the new gold rush at Weepah, Nevada, which has spread its fever up and down the California border and ushered in a new romance of treasure.

Dig your fist into rocky soil at Weepah, Nevada, and you may pull out a handful like this! A hundred dollars' worth of gold was panned from it

The two boys, Leonard Traynor and Frank Horton, Jr., dug up chunks of rock streaked with gold in ribbons half an inch wide. News of the find traveled swiftly. Prospectors, merchants, clerks, financiers and tourists drove across the sagebrush to Weepah in thickening clouds of dust. There was a scramble for claims. Other lucky strikes followed. Ed McKelvey, veteran miner, strolled in from the hills with surface gravel valued at $50 a pound. Pine Nut Johnny, a Piute Indian, brought news of another rich find at Barrel Springs, five miles away.

Within two weeks a forest of claim stakes sprawled over some 4,000 acres of desert, and a lifeless stretch of sagebrush and sand had been transformed into a mining camp of tents and shacks. Claims brought as high as $50,000.

Today the gold fever is raging along a thousand-mile front from Phoenix, Ariz., in the south, along the California boundary to Oregon and Washington. Goldfield, Nevada, scene of a great rush of two decades ago, experienced a sympathetic boom. In the Arizona desert a race of motorists began when two old-timers, Dan McGraw and James Girard, told of a pay streak assaying $100,000 a ton in the hills near Dripping Springs. In California another rush centered in the Rand district, near Bakersfield, a region of deep mines which have produced millions of dollars in gold and silver. Similar symptoms appeared as far north as Walla Walla, Wash., where J. D. Walter, a butcher, found six gold nuggets in the crops of two chickens.

EXCEPT that the old spirit of adventure and the thrill of gambling for big stakes are there, this new stampede is far different from the famous gold rushes of the past. For in the three quarters of a century since the California madness of '49; even in the quarter century since the hectic days of the Klondike, Tonopah and Goldfield, mechanical science and electricity have wrought mighty changes. The prospector's slow-moving burro has surrendered to the flivver, the roadster, even the airplane. Electric lines are projected to supply the new mining camp with light and power. For a time the prospector's pick, shovel and pan may serve to locate "pay streaks"; but soon hand tools must give way to blasts, electric drills and modern mining machinery.

For in the part of Nevada where Weepah lies, most of the precious yellow metal is hidden in rocks—in deep-running veins of quartz, or lode. Unlike the placer deposits of early California or the Yukon, where miners washed golden dust from the gravel of streams, the Nevada treasures must be recovered by sinking deep shafts and running levels and drifts to follow the lode. Electric hoists must raise the quartz to the surface. Other machinery must crush the rock to powder and from it extract the gold by washing and other metallurgical processes. This is known as quartz mining, as distinguished from placer or hydraulic mining.

At Tonopah, Goldfield and other workings, veins of quartz have been followed for thousands of feet. In the famous Comstock lode, shafts were sunk so deep that miners were able to work only an hour or so at a stretch because of the unbearable heat.

Vein mines such as these gradually are "worked out" and abandoned. Then it often happens that some lucky prospector stumbles on a rich new vein where it crops out near the surface, just as did the two boys exploring the badger hole.

NO ONE knows for certain just how the veins of gold-laden quartz came to be in the rocks. Geologists generally believe that in ages past deep subterranean streams carried silica and gold in solution under terrific heat and pressure. During one of nature's upheavals these waters geysered up, filtering through cracks and fissures in the earth's crust. There the silica crystallized into quartz, and the

Scene at the gold rush camp at Weepah. The "lucky strike" was made in a low hill overlooking the camp, which originally had only four frame dwellings. Spreading like wildfire, the news brought a population overnight, to transform the desert spot into a place of tents, shacks and automobiles

The two boys who, while prying into a badger hole, made the strike that started the Weepah rush: Right to left, Frank Horton, Jr., Leonard Traynor and young Horton's father

gold with it, filling crevices between rocks and thus forming veins.

An unusual feature of the Weepah strike, say the old-timers, was the discovery by Ed McKelvey of rich gravel or placer deposits on the surface, in addition to the lode. The presence of this "pay dirt," they declare, may cause trouble in the new mining camp; for under the state laws prospectors are permitted to file placer claims on areas already staked out for quartz or lode mining. Thus two classes of claims may be filed on the same area, the placer miner being entitled to all the gravel down to the regular lode.

The great placer discoveries, such as those of California and the Klondike, usually have been along streams. Through the ages, as mountains have been worn away by the elements, particles of gold have been washed with the soil into streams. The metal sinks to the river bed, the lighter material being carried away.

AS STRANGE and romantic as the story of the Weepah badger hole have been the histories of the richest placer finds. The stampede of '49, for example, was ushered in by two men engaged in the prosaic work of building a sawmill on the fork of the American River, near the present site of Sacramento, Calif. One of them, examining the tail race of the mill, was attracted by a glitter in the sand at the bottom. Within a year hundreds risked hardship, danger and death to explore neighboring streams. Fifty years later the story was repeated in the Yukon, when men braved the Alaskan wilderness to sift golden gravel from the Bonanza, Eldorado and other treasure-filled creeks. In a single year they won $22,000,000.

The heaviness of gold which has settled on stream beds is the quality which men have employed to advantage in developing methods of placer mining, in which the gold is separated from the gravel by washing. The simplest method, and the one widely used in early days when surface gold was comparatively common, is known as "panning." The prospector fills a shallow pan about two thirds full of "pay dirt." Then he holds it in a stream and shakes it in such a way that the water carries away the lighter material, leaving the gold at the bottom. The gold is finally recovered by further washing or "panning out." The pan is used now only in prospecting.

"Seldom Seen Slim," familiar figure in the hurly-burly Weepah camp, places a monument on the claim he staked

An elaboration of this method was the "cradle" used to wash "pay dirt" in larger quantities. This was a box, mounted on rockers and fitted with a perforated bottom of sheet iron. While water was poured over it, the cradle was rocked, causing the pay dirt in it to sift through on to an incline stripped with bars of wood called "riffles," to catch the gold.

IN LARGE scale placer workings the most effective methods have been sluicing and hydraulic mining. The sluice is a shallow inclined trough through which a stream of water is directed. When the pay dirt is shoveled into the upper end of the trough, the gravel is carried downstream, while the heavy gold settles and accumulates on the floor of the trough, which is laid with riffles. Hydraulic mining, or mining by water pressure, is used to recover free gold from large gravel beds. Powerful streams of water tear away the gravel and carry it into sluices.

For working gold-bearing river beds, huge bucket dredges have been used extensively in the West. The gravel, dug by the dredge, is put through screens, and the finer material passes to sluice boxes provided with riffles.

In these last three processes mercury has been employed to aid in capturing the gold by amalgamation, the mercury later being removed by distillation.

Dry gravel beds where once a river flowed are the chief hiding places for those treasured lumps of gold—nuggets—which are the dream of every prospector. One of the most famous of them, the "Welcome Nugget," was picked up at Ballarat, Australia, half a century ago by a penniless fortune hunter. It weighed 185 pounds and was valued at more than $50,000. The largest nugget ever recorded was discovered at Hill End, in New South Wales. It was about five feet long, three feet wide, and four inches thick, and sold for $148,000! Scientists believe nuggets have been formed by the massing together of smaller grains of gold in the rough and tumble of time. In placer deposits the richest treasures ordinarily are found at the bottom of the gravel beds close to the bedrock. Sometimes, when the gravel beds are unusually thick, shafts and tunnels must be built to reach the best pay dirt. These are known as tunnel claims.

As alluring as nuggets are the fabulously rich veins occasionally opened up in the quartz deposits. The "lucky strike" at Weepah is a shining example. Here is a district that has been mined, off and on, for

(*Continued on page 138*)

Pitching a tent on the road to El Dorado: Gold seekers who have raced by automobile to the remote corner of the Nevada desert, resting up before searching the barren hills that may give reality to their dreams of wealth

An Amazing Vision *of the* Future

Scientist Foresees a World Run by Radio

By ROBERT E. MARTIN

"THE present is only the very beginning of an age of discovery—and the next century will mark the greatest advance of civilization in the world's history." So says Prof. A. M. Low in his new book, "The Future," a tale of wonders such as no fairy tale ever presented, of the marvels science has in store for the future. Professor Low, British scientist, depicts a future more fantastic than anything most of us could imagine.

The typical man of the future, he thinks, will be called by a radio alarm clock in the morning to take a few moments' radio light treatment or massage. Then he will jump into his synthetic felt one-piece suit. He will wear his hat almost continuously, because everyone will be bald. He will have to watch out lest he put on his wife's clothing by mistake, for men and women will dress almost alike.

During breakfast a loudspeaker will tell him of news events, and he will watch some of them as they occur on a television screen. By altering the wave length, he can hear the kind of news he wishes. His breakfast may come from the communal kitchen by tubes. Telephone messages that were automatically recorded while he slept will then be read, and so too will the news received on his radio tape machine.

This business man of the future, traveling to his office in his car, will get in touch with it on the way by radio and dictate to a pocket dictaphone. An elevator will carry the car to his floor. All office buildings will have moving stairways, the streets moving sidewalks and the stores moving floors. Most of his travel will be by air, and he will week-end in Africa or Australia.

The world he lives in will be much quieter than it is today, for noise will have to be eliminated before long. Already there is proof that noise raises the temperature of a room and has a destructive effect upon mechanism. Even noiseless subways may be attained, Professor Low says; London already has a type of underground train in which you can hear a watch tick, the cars having asbestos-filled roofs, special windows, and hoods over the wheels to deflect noise.

THIS soundless world may be lighted at night by radio oscillation, for wireless has many of the characteristics of light. There will be stations to broadcast light, which all buildings will tap as required.

Future man will carry a pocket radio set everywhere he goes, and television will make long-distance business conferences possible. It will also make it possible for schools to link up, hearing and "seeing" the same university lecturer at the same time and following the lecture by diagram upon a wireless-controlled blackboard.

Future man, says Prof. Low, will wear synthetic clothes, eat out of tubes and see news by television

In its earlier stage of development, as Professor Low visions it, radio power will be distributed locally from cables under the principal roads, and vehicles will pick up the power through their motors. Factories will be built in the country and run by power broadcast from huge stations.

But all this is nothing to what may be accomplished by control of the electronic emanations. "If matter is the result of defined electric vibration," Professor Low asks, "could we not transfer our tables, our chairs and ourselves, in effect, by a knowledge of the forces which produce these oscillations?" Future man may watch a bale of goods being whirled through space from Europe to South America, traveling, so to speak, under its own power!

AS FOR the automobile, it will give man service and thrills that the automotive industry today does not dream of. It will be a stream-lined car with flexible body, inclosed in flexible glass, with four or six disk wheels shrouded. The interior will be air-cushioned. The engine will probably be of a gasoline steam turbine type, totally inclosed, and will not have to be tinkered with more than once a year. Eventually, power for vehicles will be tapped from the air by beam-wireless at any time or place.

Some day, too Professor Low predicts, there will be a wonderful Pegasus vehicle, an aerocar, that can fly as well as ply the roads. It will be equipped with a radio telephone and loudspeaker, a milometer, inclinometer, barometer, averometer, speedometer and thermometer. Control instruments will be easily operated with a light touch and gear changing will give way to automatically variable gears or to engines which can give power over a wide range of speed.

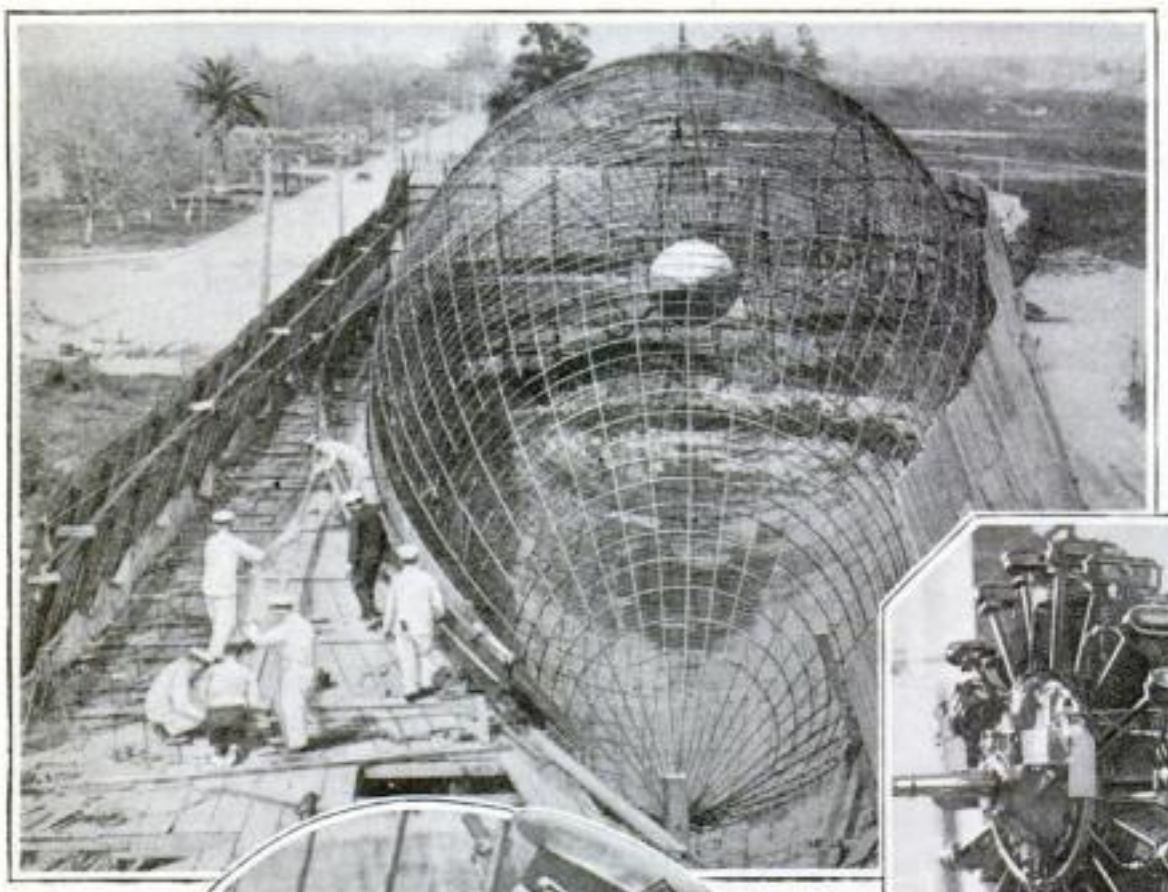
Chemistry's great immediate future will be along the lines of atomic disintegration, and Prof. Low sees no doubt that we will be able to construct synthetically more and more materials used in everyday life today as direct products of nature.

Greatest marvel of all, perhaps, will be the transfer of power to the Earth from other planets. This is quite possible, Professor Low thinks, and he sees nothing fantastic in the idea of interplanetary communication. Light signals from a super-searchlight beam thrown by ten thousand giant calcium flares and reflectors, developing a light of two million billion candlepower, might span the 35,000,000 miles that separate Earth and Mars when they are nearest, or it may be done through wireless, for the most powerful transmitting station is believed capable of reaching the Moon.

"It is far from fantastic," he says, "to believe that in our near future, as knowledge of this wonderful force improves, it may be possible to span the distance by sending directional waves or combinations of waves, of enormous strength.

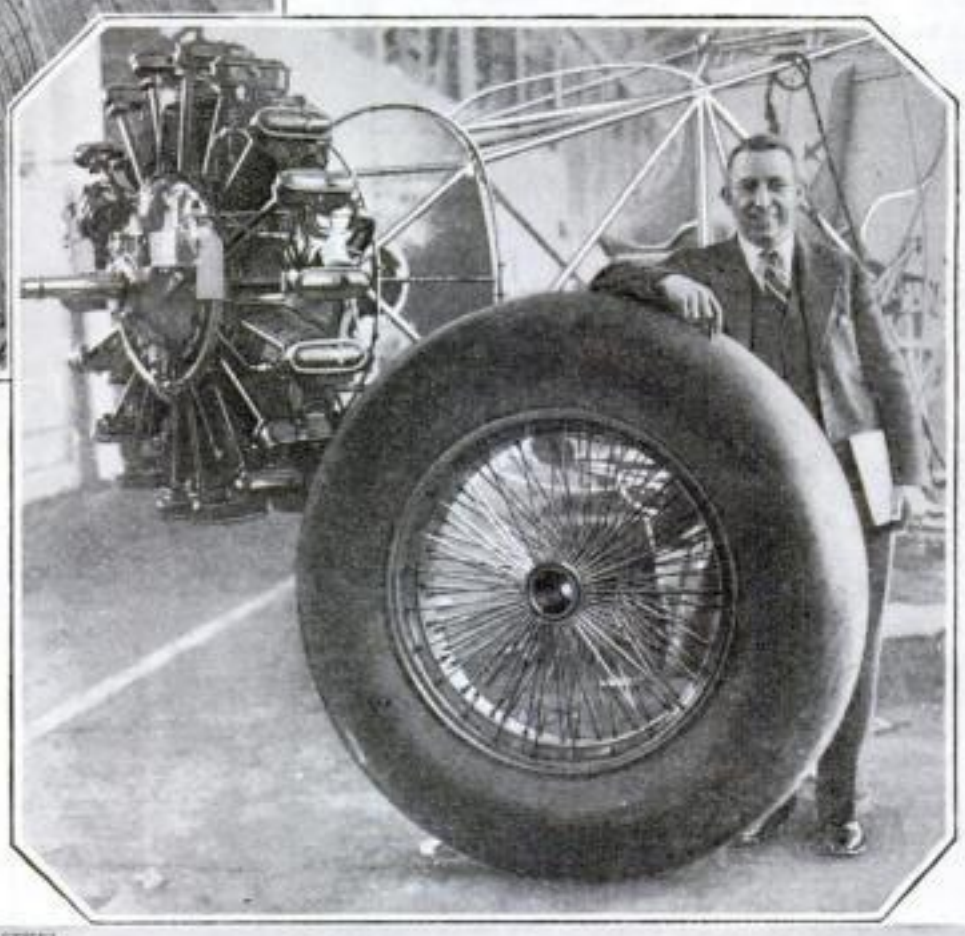
"There is no limit to the adventure of men into the terrific realms of science!"

The Progress *of* Aviation

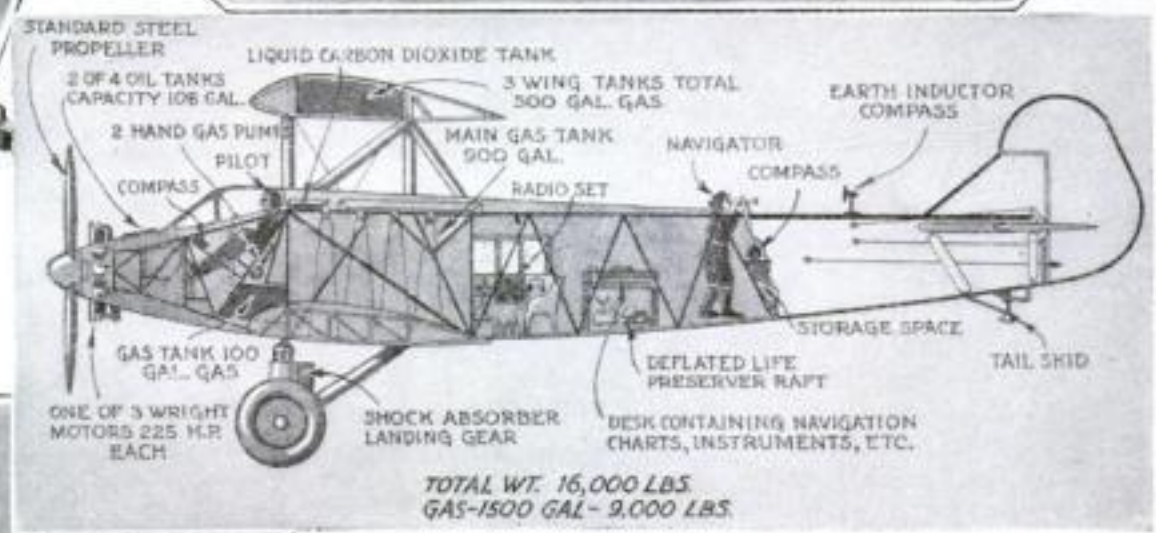


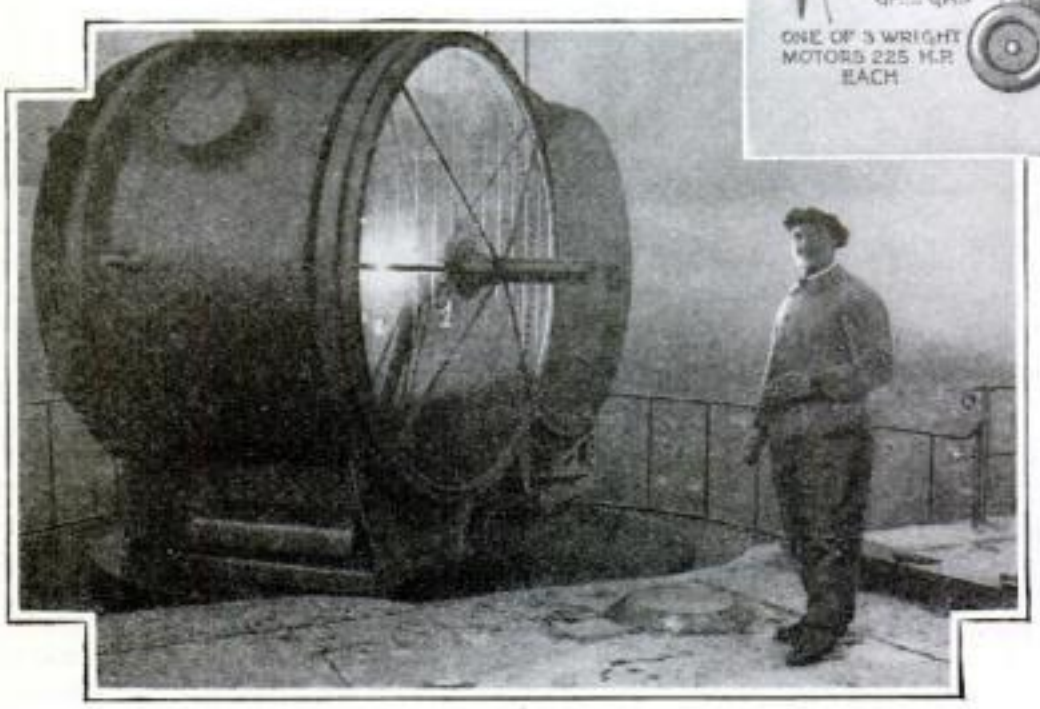
An amazing propellerless all-metal airship is being built by Thomas Benton Slate, well-known engineer, at the Glendale airport, Calif. Planned on entirely new principles, it will be neither pushed nor pulled through the air, but will "float" by air pressure from behind. A radial blower in the ship's nose will create in effect a vacuum in front of the dirigible, air pressure from behind constantly pushing the ship forward into this vacuum. The duralumin envelope will not be divided into sections but will constitute one great metal gas bag. The power plant comprises two turbines. The new airship, pictured in construction at the left, will be entered in competitive bidding for Government dirigibles

Thomas Benton Slate, building a new airship he hopes Uncle Sam will adopt



Lieut. Commander Noel Davis, contender in this summer's New York-to-Paris race for the $25,000 Orteig prize, is pictured above beside the huge wheel to be used on his plane. Below is a sketch of the giant Keystone Pathfinder being built for him. A most unusual feature is the huge gasoline tank, holding 900 gallons, carried in the fuselage to concentrate weight instead of being divided, as is usual with large planes. Thick wings give the plane unusual lifting power

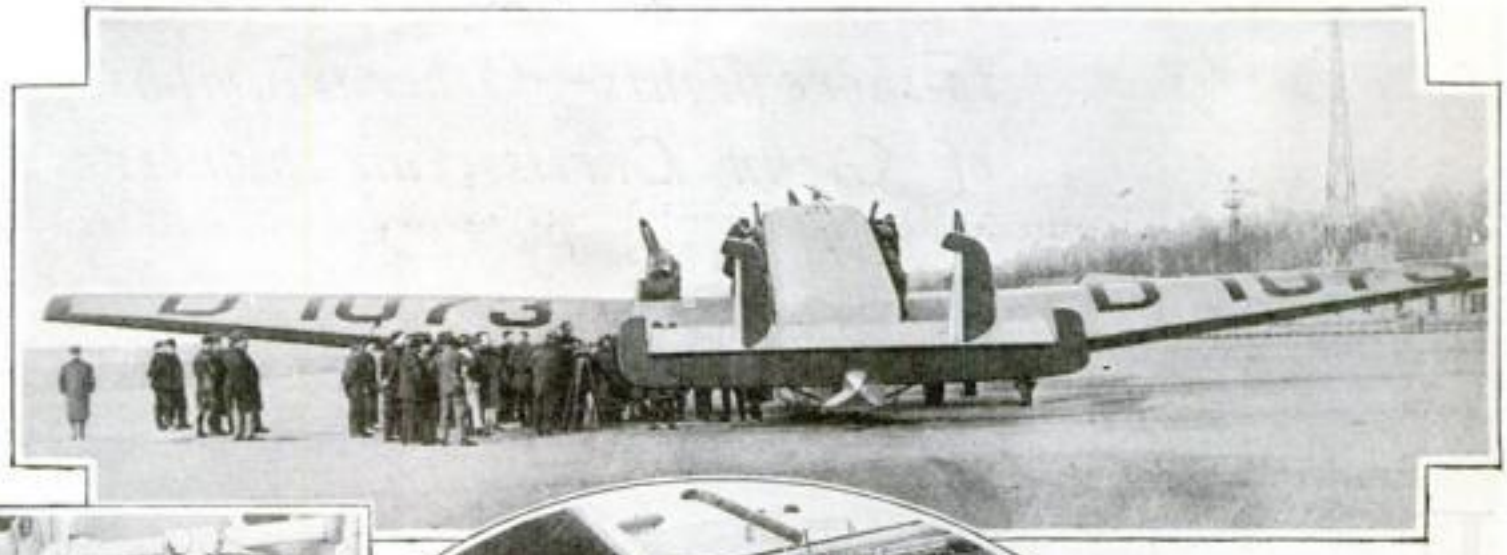


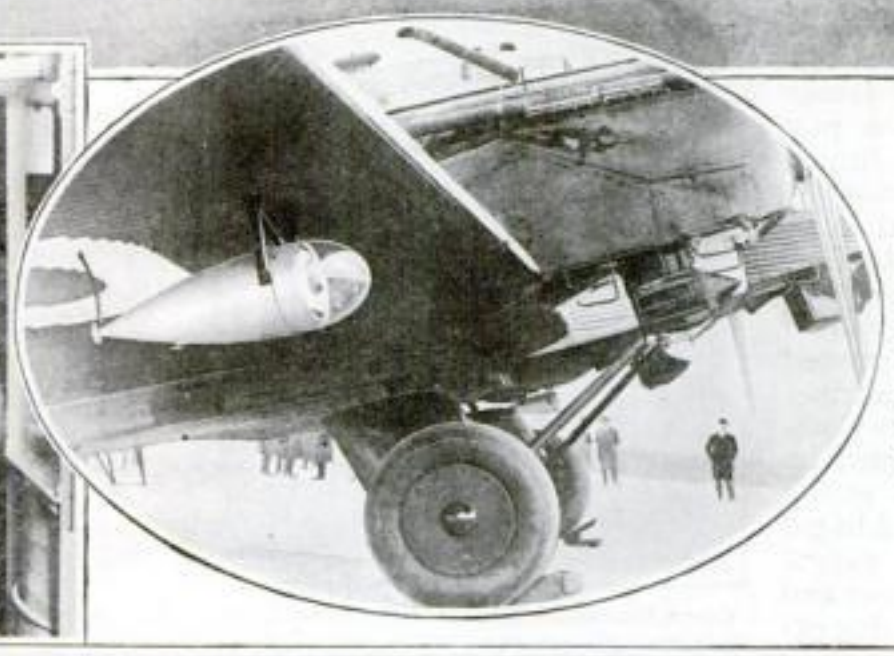


Called the world's largest land lighthouse, this giant beacon, at Mt. Valerien, near Paris, guides airplanes at night on the London-Marseilles-India route. Revolving beams from its twin six-and-a-half-foot reflectors are visible ninety miles away, and the light of a billion candles is thrown out from them through space

Californian Builds Propellerless Dirigible—Latest German Super-Ship—Ninety-Mile Beacon for France—Other Advances

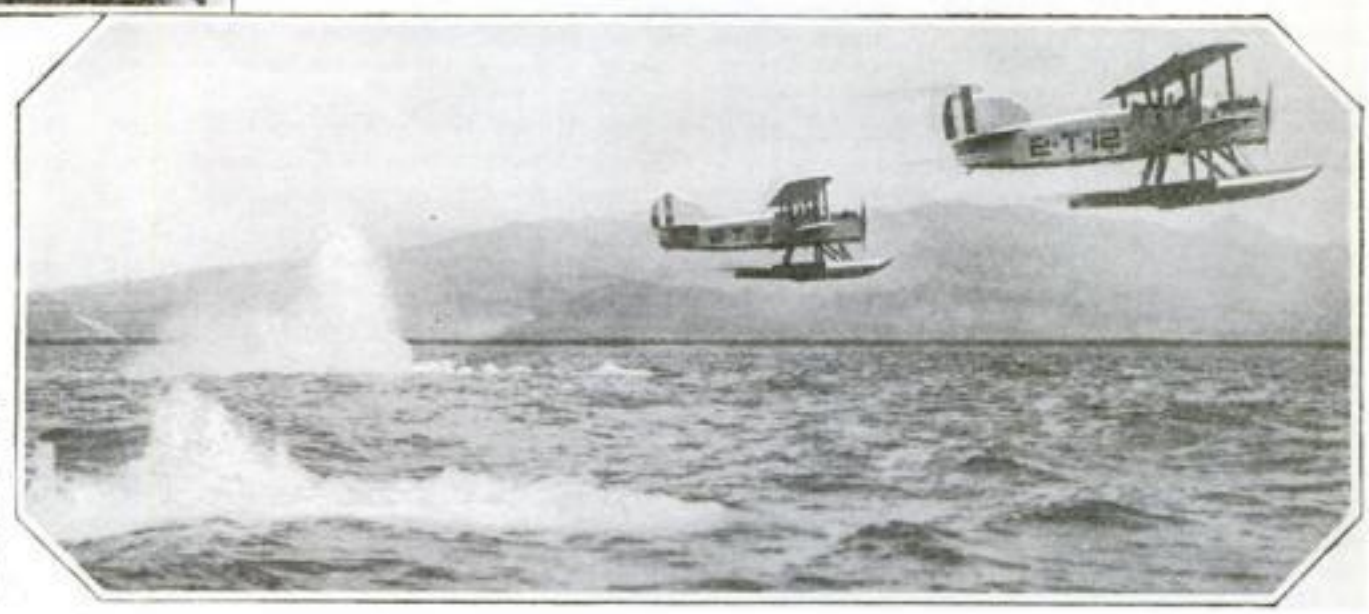
At right, newest link in Germany's air chain—the huge Junkers monoplane, carrying twenty passengers, with sleeping accommodations for twelve, which recently made its first flight from Dessau to Venice. Equipped with three 400-h. p. engines, it can fly 650 miles without landing, at an average speed of 115 miles an hour



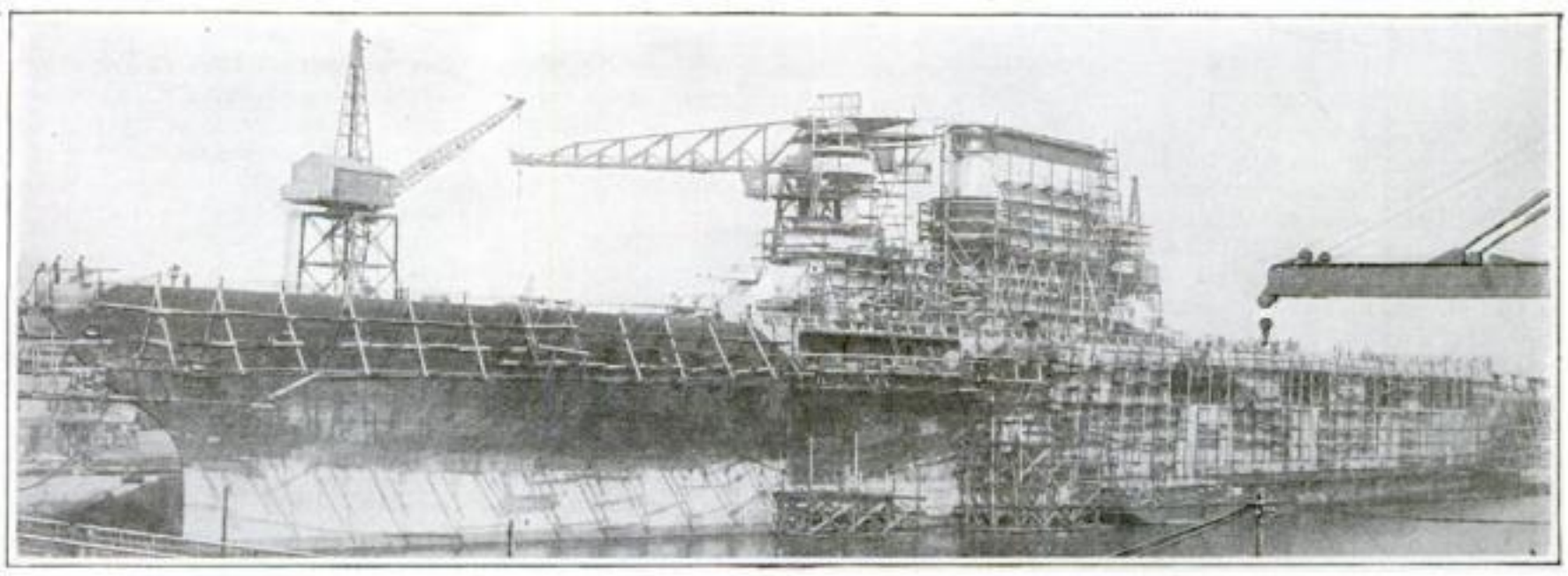


(Left) Powerful searchlights on the Junkers plane aid night landing. The plane weighs nearly eight tons, and the Germans are already planning supergiants of 150 tons and predicting an eventual size of 20,000 tons!

Above, candidate for a Navy pilot's license being tested with a new "rebreathing" apparatus to show how high he can fly without additional oxygen. He inhales the same air over and over through a mask while handling various levers and controls, until he becomes sleepy and confused



(Right) Two torpedoes race through the water while the seaplanes that launched them soar out of reach of the enemy ship's guns, in this unusual photo, snapped during maneuvers at San Diego. The picture vividly demonstrates the grim effectiveness of the torpedo plane as a war weapon



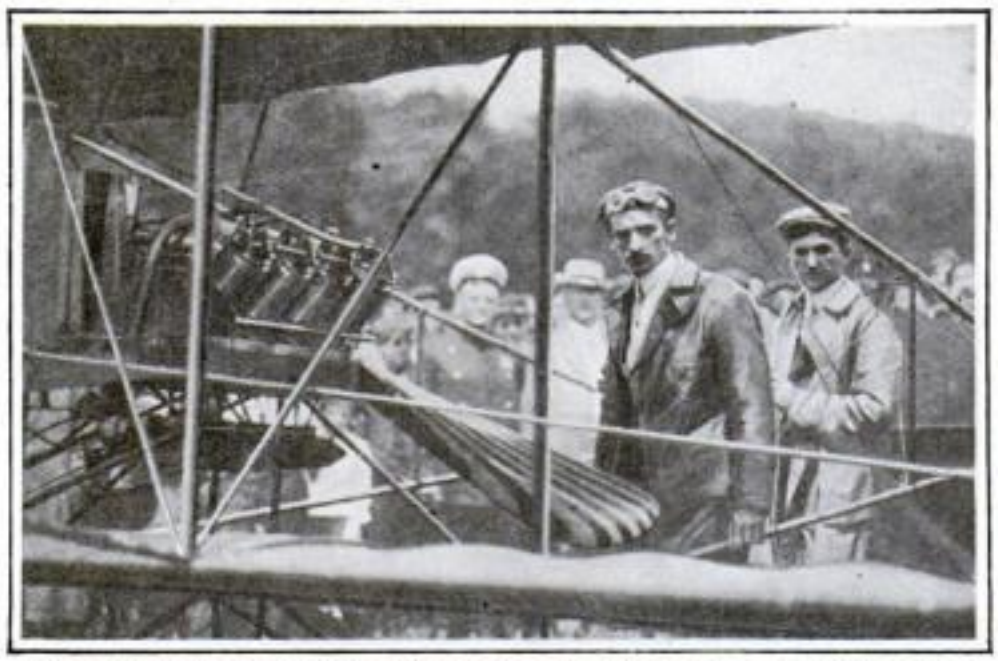
The *Lexington*, newest American airplane carrier, receiving a coat of battleship gray at the Fore River shipyards, Quincy, Mass. Two new airplane carriers will be added to Uncle Sam's naval defense forces with the completion this fall, at the Fore River yards, of the *Lexington* and the *Saratoga*. Both the ships will be equipped with the latest landing and take-off devices

How Sea Flying *Was Made* Safe

The first hydroaeroplane—Ship-to-shore flights—Other triumphs of Glenn Curtiss, air pioneer

By

FRANK PARKER STOCKBRIDGE



Glenn Curtiss landing in New York City after flying down the Hudson from Albany. He covered the 152 miles in two hours and fifty-one minutes—one of the most significant feats recorded in this series of articles, the fourth of which is on these pages. Above, photos of the Langley medal, awarded Curtiss in 1914

ENTHUSIASTIC delegations met Glenn Curtiss at the pier when he returned from Europe. His victory at the first international aviation meet in France had fixed him as a national hero.

All America now wanted to see him fly. Scores wanted him to build flying machines for them. The Curtiss Company had been enjoined by the Wrights against selling airplanes. Curtiss had to get money to fight the patent litigation. The quickest and easiest way was by giving exhibition flights.

That summer of 1909, the city of New York staged a double celebration, the three hundredth anniversary of Hendrik Hudson's discovery of the river and the centennial of Robert Fulton's voyage in his first steamboat. The promoters planned a great procession up the Hudson. Replicas of the Half-Moon and the Clermont were to be convoyed by a fleet of aircraft. Popular imagination, fired by the amazing things already accomplished in the air, leaped fifty years beyond possibilities. Tremendous was the disappointment when the airships failed to perform according to promise.

Glenn Curtiss, keeping a promise which he had made before sailing for France, took a plane to Governors Island, in the upper bay, and waited for favorable winds.

A CANNON shot was to be the signal for the start of his flight. But so many cannons and bombs were being fired that few paid attention when, at last, he made a short flight in the direction of the Statue of Liberty and returned to Governors Island. He had an engagement for an exhibition flight at St. Louis and had to hurry away without competing for the prize of $10,000 which the *New York World* had offered to the first airman to fly over the route of Hudson and Fulton, New York to Albany, or in the opposite direction.

A few days later Wilbur Wright flew his plane several miles up the Hudson River. "That was really a magnificent flight, considering weather conditions and the stage which flying had reached at that time," Glenn Curtiss said to me.

For exhibition flights Curtiss devised a "knockdown" airplane. The wings came apart in sections. Everything packed into compact cases; he could carry his plane as personal baggage anywhere. This was the machine he took to St. Louis, where tens of thousands saw an airplane in flight for the first time and cheered the evolutions of Captain Tom Baldwin, Roy Knabenshue and Lincoln Beachey in their Baldwin-Curtiss dirigibles.

Then to Los Angeles, for the first international flying meet ever held in America. Louis Paulhan was there for France. Curtiss and his first pupil, Charles F. Willard, whom he had taught to fly at Mineola, were there.

New records were made for cross-country flying, for speed, for altitude. Louis Paulhan flew higher than anyone had ever gone before—4,165 feet!

THIS was in January, 1910. Glenn Curtiss got off the ground in six and two fifths seconds after a run of only ninety-eight feet. He won $6500 in prizes, for speed, for endurance, for getting off the ground in the shortest time. On April 10th at Memphis he clipped three fifths of a second off his Los Angeles starting time. At San Antonio, on April 23rd, he lowered that another tenth of a second. The next day, in the same place, C. K. Hamilton, one of the first of the Curtiss galaxy of flying stars, got off the ground in less than four seconds, with a run of only seventy feet.

By the beginning of 1910 there were ten airplanes at once going through the Curtiss works at Hammondsport. Quantity production! Dozens of young men were learning to fly. Willard, Hamilton, J. C. Mars, who had been a balloon man with Capt. Baldwin, Lincoln Beachey, Eugene Ely, C. C. Witmer, Lansing Callon, "Gink" Dougherty and others who later won fame in the air, joined the Curtiss exhibition forces. To teach them to fly, Curtiss invented the "grass-cutter," an airplane with the wings amputated so that it could not rise more than a foot or two. Pupils practiced with it until manipulation of the controls became automatic.

In the three years following the crowning of Glenn Curtiss as king of the air at Rheims, more than two thousand exhibition flights were given by his pupils and himself. He neither sold the planes to these exhibition flyers nor employed them; the first would have further complicated the patent litigation of the Wrights, while the second would have made him liable for damages in case of accident. He taught his men to fly, then leased the machines to them; they took their own risks.

Extra hazardous risks, some of them, particularly the stunts which Lincoln Beachey insisted on trying. The newspapers reported that a Frenchman had looped the loop with an airplane; nothing would do for Beachey but to try it himself. What would happen when the engine turned upside down and the gasoline leaked out of the carburetor? That worried Curtiss.

"I CONFESS I don't know yet why he didn't set his machine afire when the gas flowed down over the hot engine," he said to me, "but somehow Beachey got away with it."

He was the dare-devil of the Curtiss flyers. His exploit in flying down the Niagara Gorge, over the boiling rapids, through unknown and treacherous air currents, was probably the greatest risk ever taken by an airman. Spray from the Falls, drawn in through the carburetor, fouled his spark plugs, and the en-

gine was hitting on only an occasional cylinder when he finally landed. The crash that ended his life a year or two later was inevitable to one of Beachey's temperament.

Wealthy sportsmen were beginning to buy airplanes. Curtiss' first private customer was A. P. Warner of Beloit, Wisconsin, inventor of the Warner speedometer. He built an aerial speed gage on the principle of an anemometer; four hemispherical cups, revolving on the ends of a Greek cross, the familiar method of measuring wind velocity. Warner gave one to Glenn Curtiss to try. One of the cups flew off and hit Curtiss in the face. He advised Mr. Warner to try another scheme.

Curtiss had not lost sight of that $10,000 purse hung up for a Hudson River flight. Nobody had got it in 1909—the prize was still anybody's. All that spring of 1910 a new machine, specially designed to win the *World* prize, was going through the Curtiss works at Hammondsport.

In May Curtiss put pontoons on his new plane, flew around the Hammondsport valley and landed safely on the waters of Lake Keuka. The first hydroaeroplane! Now he could undertake to fly the length of the Hudson River with assurance that he would not be drowned if his plane failed.

HE SPENT days preparing for the flight. Searching for landing places along the route where he could descend for gas and oil, or in case of accident, he stopped at Poughkeepsie, halfway between New York and Albany. Here he found a splendid one, on the grounds of the State Hospital for the Insane.

"When I told Dr. Taylor, the superintendent, that I intended to stop there on my way down the river in a flying machine, he said, very politely: 'Why, certainly, Mr. Curtiss, come right in here; here's where all flying machine inventors land!'" Curtiss tells, chuckling at the reminiscence. That was the attitude, still, of everybody who had not seen an airplane flying in the air.

His plane, the *Hudson Flyer*, was set up on Rensselaer Island, between Albany and Troy. Crowds came to see it. All the great newspapers sent reporters. The *New York Times* chartered a special train to race the airplane down the river whenever Curtiss should start. And Curtiss waited.

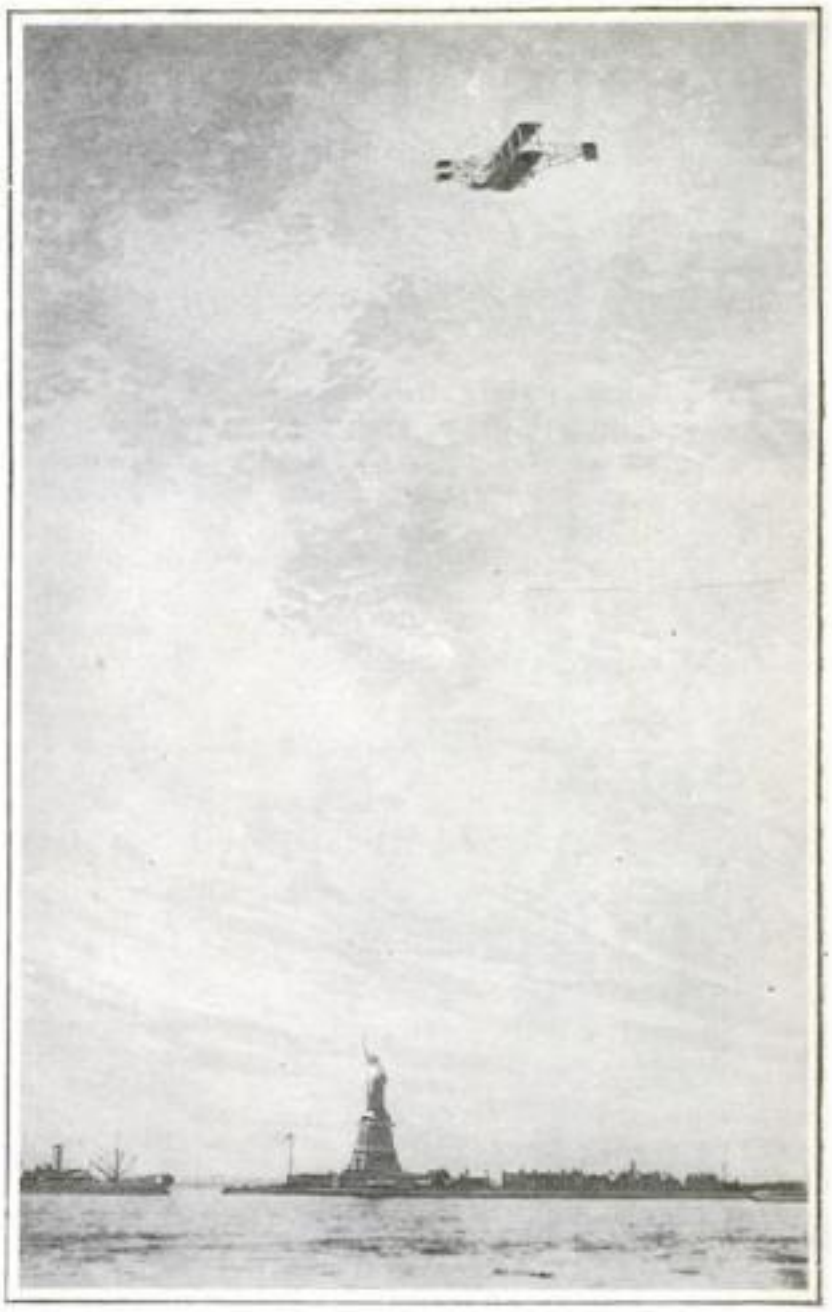
ON THREE different mornings he got up at daybreak, ready for an early start, then decided there was too much wind. He put in his time with his mechanics, tinkering while the impatient newspapermen openly accused him of being a faker. Editors all over the country printed gibes.

At last, at dawn on the morning of May 30, 1910, Curtiss announced he was ready. The reporters flashed the news to their papers. Holiday crowds lined the river banks—and Curtiss didn't start! The weather at Albany was fine, but the telegraph brought reports of strong winds blowing northward up the river. By nightfall of that Memorial Day the newspapers and the public were convinced that nobody would ever even try to fly down the Hudson. Then, the next day, Sunday morning, Glenn Curtiss started out and did it.

"I was getting as tired of waiting as anybody else," he told me.

It was just after eight when he rose into the air. The day was calm, his motor running perfectly. The special train started as he did, slipping down the water-level rails of the New York Central at fifty miles an hour. Curtiss flew abreast of it, and passed it. No trouble to go fifty, even more, miles an hour now.

Every inhabitant along the upper Hudson turned out, steamboat men swung their caps, tugs sounded their sirens, but the flyer heard nothing but his motor exhaust. He flew over the Poughkeepsie bridge, 150 feet above the rails, then circled eastward to a landing field at Camelot while the population stood on hillsides and roof tops and cheered. Down to a safe landing—and nobody there with gas and oil as he had arranged! The man entrusted with the job of providing fuel and lubricant did not believe Curtiss was ever coming!



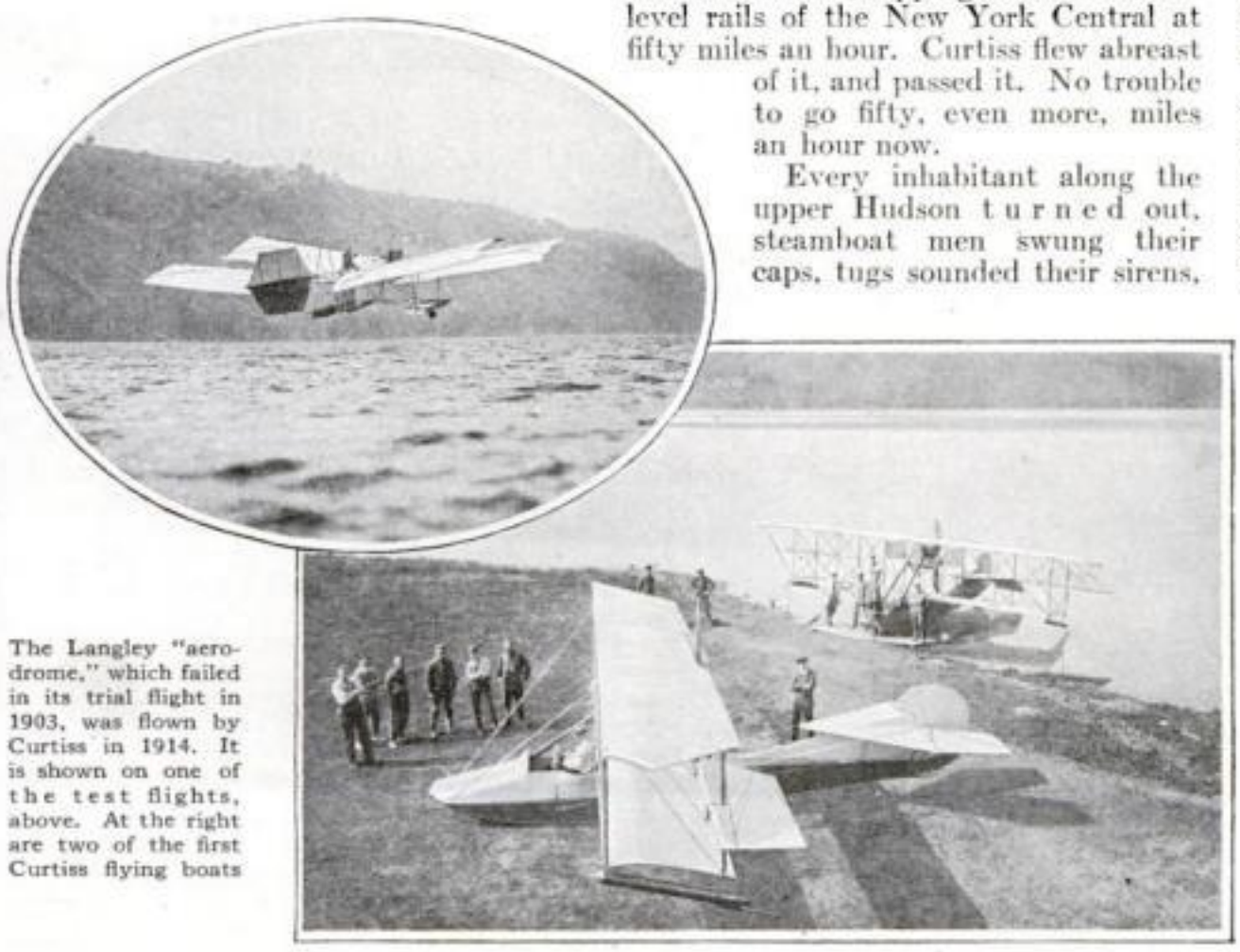
Circling the Statue of Liberty at the finish of the Albany-New York flight. Curtiss had put pontoons on this plane, producing the first hydroaeroplane

SEVERAL motorists volunteered help, and in a few minutes, with tank and crank case replenished, Curtiss rose for the second leg of the great flight. Even at that point he had already won the *Scientific American* trophy for the third time, with the longest continuous flight ever made—eighty-seven miles, from Albany to Poughkeepsie.

Approaching the Hudson highlands, Curtiss had his first experience with "holes in the air," that carry the plane downward irresistibly, occasionally taking a flyer's life as toll.

The air boiled like a gigantic teakettle, cross currents, upward currents, downward currents, that let the airman fall until once he almost touched the water with a wing tip. Sudden drops of a hundred feet that seemed like a thousand. No man ever had tried to fly through air like this.

But in a few seconds the placid expanse of the Tappan Zee lay below him, the hazard passed. Crowds on the river (Continued on page 141)



The Langley "aerodrome," which failed in its trial flight in 1903, was flown by Curtiss in 1914. It is shown on one of the test flights, above. At the right are two of the first Curtiss flying boats

Facts Everyone Should Know

These Fifty-Eight Questions Offer a New Way to Test Your Stock of Useful Information

HOW large is your stock of useful information? Have you learned the secret of selecting valuable facts and figures from the general run of information, and of sorting them in mental pigeonholes for future reference? Or have you allowed knowledge, once gained in school or elsewhere, to escape you through neglect or disuse?

The four fascinating tests given below will tell you. They were devised recently at Columbia University as a test of general knowledge of science.

At first glance, the tests may appear difficult; but you will see that they have been simplified by the fact that in each case a list of the answers is given at the outset. All you need to do is to fit the various answers into the correct spaces.

There are fifty-eight questions in all, including the dates of discoveries and inventions. If you answer thirty-five of them correctly you may be reasonably sure you are "well informed." If you score more than thirty-five you can put yourself down as exceptional. The correct answers appear on page 139.

Terms Used in Applied Science

THIS test will measure your familiarity with terms of applied science. See how many of the following ten terms you can place correctly in the spaces before the numbered statements.

pasteurization	filament	Bessemer converter
turbine	gyro-stabilizer	cyanometer
ammeter	carburetor	
armature	radioactivity	

_____ 1. The rotating part of a motor or dynamo.
_____ 2. The fine wire in an electric light bulb which gives off light.
_____ 3. An instrument for mixing gasoline and air to form an explosive mixture.
_____ 4. An instrument for measuring electric current.
_____ 5. A vessel for holding molten iron and changing it into steel.
_____ 6. A rotating machine which derives its power from water or steam.
_____ 7. An instrument for measuring the color of the sky.
_____ 8. A huge spinning top used to prevent rolling of ships at sea.
_____ 9. The property which some substances possess of giving off invisible but penetrating rays.
_____10. The process of heating milk to destroy bacteria and prevent souring.

Great Inventors and Inventions

HERE are the names of twelve inventors and discoverers, and the dates of their important achievements. In the space before each of the twelve numbered statements write the correct name, and at the end write the correct date.

Isaac Newton	George Westinghouse	Olaus Roemer
Elias Howe	Samuel F. B. Morse	Galileo Galilei
James Watt	Alexander G. Bell	Richard Gatling
Thomas Edison	Cyrus McCormick	Johann Kepler

1837	1609	1834	1769	1893	1861
1687	1876	1675	1845	1609	1868

Inventor *Date*

_____ 1. Invented the first successful steam engine _____
_____ 2. Invented the telegraph _____
_____ 3. Invented the moving picture machine _____
_____ 4. Formulated the law of universal gravitation _____
_____ 5. Invented the air brake _____
_____ 6. First measured the speed of light _____
_____ 7. Discovered the laws of motion of the planets _____
_____ 8. Invented the sewing machine _____
_____ 9. Invented the reaper _____
_____10. Invented the telephone _____
_____11. Invented the machine gun _____
_____12. First person to make and use the telescope _____

Your Mental Measuring Stick

HOW accurately does your mind serve you as a measuring stick? Try to place each of the following twelve numbers in its right space before one of the statements below.

.000039	57¼	660	6,080
.4	231	2,204.6	43,560
6	640	5,280	6,000,000,000,000

_____ 1. Number of feet in one mile.
_____ 2. Number of pounds in one metric ton.
_____ 3. Number of acres in one square mile.
_____ 4. Number of square feet in one acre.
_____ 5. Number of degrees in one radian.
_____ 6. Number of inches in one centimeter.
_____ 7. Number of feet in one knot (one nautical mile).
_____ 8. Number of inches in one micron.
_____ 9. Number of miles in one light-year.
_____10. Number of cubic inches in one gallon.
_____11. Number of feet in one fathom.
_____12. Number of feet in one furlong.

Remember These Measurements?

IF YOU are familiar with the different units of measurement, how widely can you apply them? See how many of the following twelve numbers you can place correctly in the spaces.

29.5	62.5	1,100	239,000
39	256	25,000	93,000,000
29,141	459.4	186,000	
		6,000,000,000,000,000,000,000	

_____ 1. Number of miles around the earth.
_____ 2. Number of feet per second sound travels in air.
_____ 3. Number of vibrations per second of middle C on the piano.
_____ 4. Number of miles from the earth to the moon.
_____ 5. Number of degrees below zero Fahrenheit of absolute zero.
_____ 6. Height of barometer in inches under normal conditions.
_____ 7. Number of miles per second light travels.
_____ 8. Mass or weight of the earth in tons.
_____ 9. Distance in miles from earth to sun.
_____10. Length in inches of a pendulum that beats seconds.
_____11. Weight in pounds of one cubic foot of water.
_____12. Height of world's highest mountain in feet.

Is There a Human *Speed* Limit?

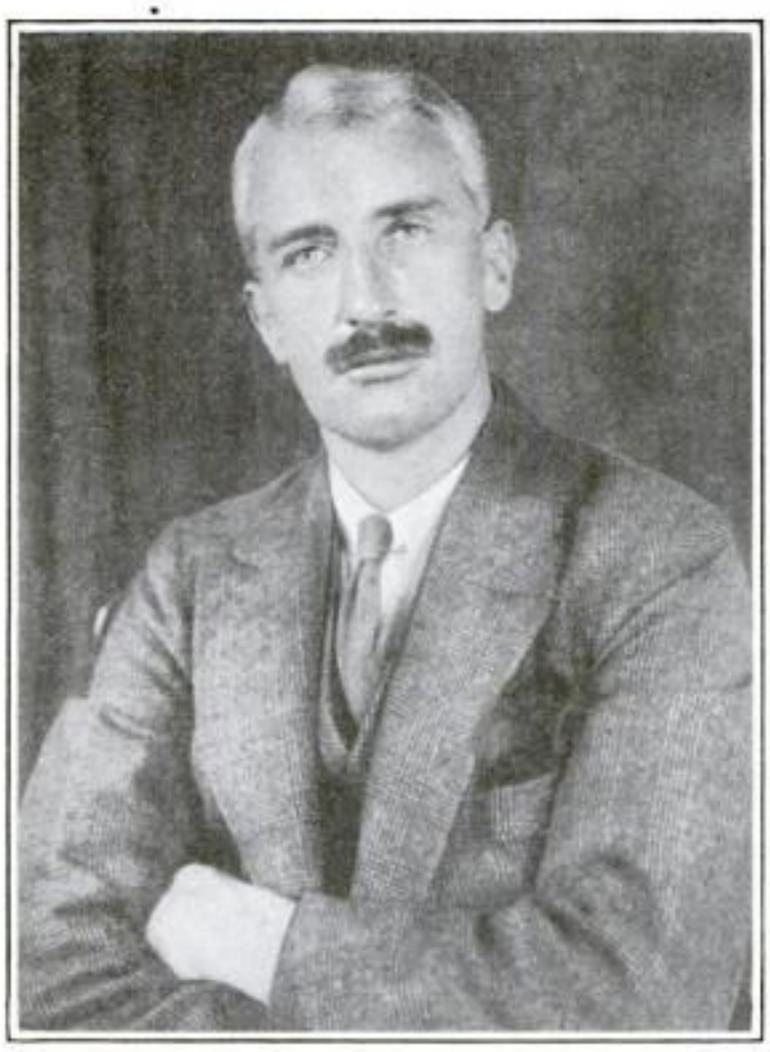
Noted British scientist's remarkable experiments with athletes have revealed many amazing new facts about the mechanics and chemistry of running

By ARTHUR GRAHAME

WHEN Charles W. Paddock, the California sprinter famous as "the fastest human," not so long ago ran 100 yards in 9 5-10 seconds, he established a new American record, clipping one tenth of a second off the mark set by Arthur Duffy a quarter of a century ago. To do that, Paddock had to run at an average speed, pistol to tape, of 10½ yards a second. In his stride, he must have been stepping about twelve yards a second, —which means that he was traveling at the lively rate of twenty-four and one half miles an hour.

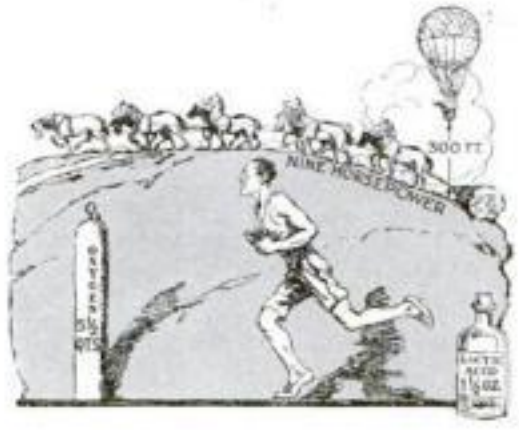
Is that the speed limit, or close to the speed limit, of the human runner? Do the remarkable records of sprinters such as Paddock and Roland Locke, and of middle-distance runners such as Nurmi and Edvin Wide, represent the utmost in speed and endurance of which the human machine is capable? Has stern and inflexible Nature established speed laws which even the greatest of athletes may not break?

Science is answering these questions. Prof. A. V. Hill, noted English physiologist and winner of the Nobel Prize in medicine in 1922, has perfected a method of enabling him to measure the characteristics of an athlete in respect to expenditure of energy and to calculate his speed for a given distance. His predictions are based on studies of the effects on the human mechanism of violent effort and of fatigue, which, in conjunction with an ingenious timing method, may result in proving that in some of the shorter running events the best athletes have come so close to the human speed limit that future record breaking is likely to be in hundredths, rather than fifths or tenths, of a second.



Professor A. V. Hill, noted English physiologist, winner of the Nobel Prize in medicine in 1922, and recently nonresident lecturer at Cornell University. In his remarkable studies of the human muscular machine, he has perfected a method of timing runners which, in conjunction with other discoveries, has changed the human speed limit from a topic of cinder track argument to a subject for serious scientific discussion

THIS timing method, offering a degree of accuracy impossible with a human timer and the best split-second watch, consists of wire coils placed alongside the track at the starting line, at the finish and at intermediate points. The runner carries, attached to his waist by a tape, a small piece of magnetized hack-saw blade, and when he passes a coil a current is induced in it, and a galvanometer attached to the coil is deflected. These deflections are recorded on moving photographic paper, marked in units of time, in a special type of camera. The start is recorded by pressing an electric key at the moment the starter's pistol is fired. The timing slips provide a detailed and easily understood record of the athlete's performance, even showing when the runner "beats the gun" by about a tenth of a second.



A man, running 100 yards in the record time of ten seconds, Professor Hill's experiments show, does as much work as would be required to lift him 300 feet in the air. He uses up 9 horsepower of energy. He generates 1½ ounces of lactic acid (muscle fatigue). And he "runs into debt" for five to seven quarts of oxygen. An athlete's oxygen borrowing capacity is a reliable index, according to Professor Hill, of his ability as a runner, more especially in distance events

When I visited Professor Hill at Cornell University, where this spring he has been a nonresident lecturer in chemistry, he was conducting experiments on a small outdoor training track. Timing coils were placed at the starting line, and one, three, six, ten, fifteen, twenty, thirty, forty, fifty and sixty yards from it. The experiments showed that with all the sprinters examined it took, at the start, about one tenth of a second for the runner to flash the order "go!" from his mind to his muscles. A runner who did the sixty yards in 7 and 56-100 seconds reached maximum speed at some moment between twenty and thirty yards, which seems to be the case with all sprinters. His last ten yards as a whole were the fastest. He covered them in 99-100 second.

"A runner," Professor Hill explained, "is subject to a retarding influence proportional to his velocity. The faster he runs, the greater the resistance he must overcome. In effect it is the same as when a raindrop falls through the air, the resistance of the air grows greater as the speed of the raindrop increases.

"The sprinter who ran sixty yards in 7 and 56-100 seconds exerted a constant force of about eighty percent of his body weight. He started with an initial acceleration equal to four fifths of gravity. In running 100 yards he would do work equal to that required to lift his body 240 feet in the air. Another runner exerted a force equal to ninety-two percent of his body weight. In running 100 yards he would do work equal to that required to lift himself 276 feet in the air.

"A SPRINTER capable of running 100 yards in record time would perform work equal to that required to lift himself 300 feet or more in the air. In running 100 yards in ten seconds a man uses nine horsepower of energy."

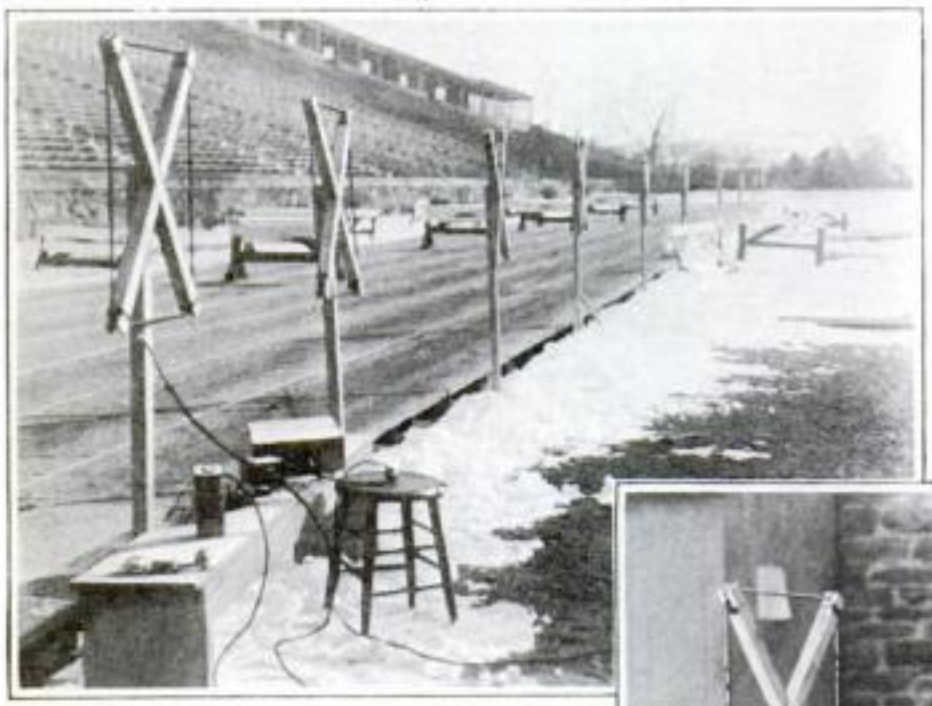
This tremendous expenditure of energy supplies scientific basis for the belief, expressed by many prominent track coaches, that, when the present sprint records are beaten, it will be by fractions of a second so small that they can be recorded only by electric timing apparatus.

"Muscles contract and relax rapidly

when a runner is traveling at high speed," Professor Hill then continued. "Lactic acid—a product of muscular fatigue, a variety of the acid that accompanies the fermentation of milk—is manufactured at the rate of three or four grams a second, and one and one half ounces of this comparatively strong acid in the muscles at the end of a fast 100 yards will result in a considerable falling off in speed. Four ounces is enough to stop the athlete completely.

"A runner traveling at high speed—say, ten yards a second—must pay a tremendous price in energy for even a slight increase in speed. At high speeds most of the mechanical energy developed by the muscles is absorbed by internal friction. Only a small part is available to move the body forward. Skill of movement is, of course, an important factor in championship speed, for poor coördination results in an unduly large production of lactic acid and consumption of oxygen, with consequent loss of speed.

"It is improbable that athletes of the future will be able to improve greatly on the starting speed of the present record holders. The strain on muscles and tendons already is tremendous. In the viscous-elastic properties of our muscles Nature has provided a safety valve for the athlete determined to break records. The inevitable falling off in muscular tension that is the result of violent physical effort keeps him from wrecking the mechanism of the body in his efforts to smash records. Once a sprinter has attained his maximum speed, the remaining distance to be run is so short that it is difficult for him to increase his speed greatly. For these reasons I do not think that there will be any startling lowering of records in the sprint distances.



The electrical timing apparatus designed by Professor Hill, with which he has been testing Cornell University runners. Wire coils are placed at intervals along the track. The runner carries a magnet which, as he passes each coil, induces a current in it, the fluctuations being graphically recorded on a chart. By this method Prof. Hill has measured runners' time down to a five-hundredth of a second

"In the longer runs a man's probable speed limit for any given distance may be determined by his oxygen borrowing capacity.

"To perform work a muscle must burn up carbohydrates, and to do that it must have oxygen. But it is not necessary that this oxygen should come directly from the outer air. The muscles store up energy as a storage battery stores up electricity, and can use stored energy as an electric motor uses stored electricity. They are able to "borrow" oxygen, and replace it after the effort has been made and the athlete is resting.

"In the sprints the athlete runs almost entirely on stored energy and breathing is of slight importance. The distance is so short that he is unable to use up all his stored energy and so exhaust himself. In the longer runs the athlete's ability to borrow oxygen and repay it later is index to his ability as a runner.

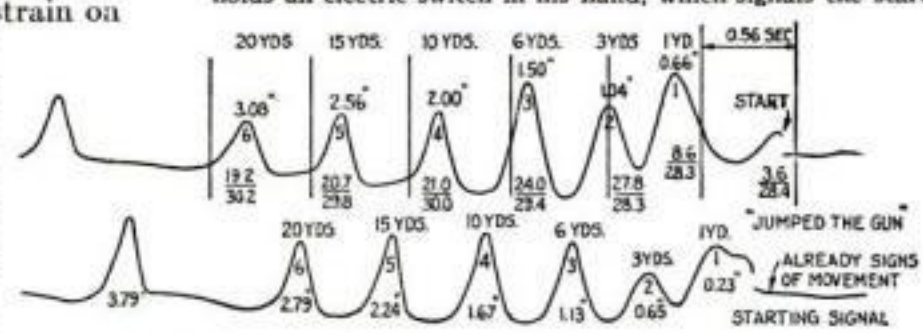
"It has been determined by experiments that the maximum oxygen intake of a runner is about three and one half quarts a minute, and that the maximum energy storage capacity is equivalent to about thirteen quarts. This gives him a total oxygen capacity of about sixteen and one half quarts. An athlete running at top speed can use up all his available energy in a little more than 300 yards. When he has done so total exhaustion is at hand."

I asked Professor Hill how he, as a physiologist, had become so deeply interested in athletics.

"MANY people ask me that," he replied. "Well, the physiologist's job is to study the chemical and physical activities of living organisms—muscles, heart, and so on. He studies, for example, the curious power a muscle possesses of adapting its liberation of energy to the work it has to do. In the marvelous performances of trained athletes he can obtain data of extraordinary exactness. Recently an athlete ran sixty yards for me, four times in succession. I had asked him to try to run at the same speed each time. His times were taken at ten points along the track, and the average difference in his times was only 14/1000 second! If I wanted similar data on industrial fatigue, where could I find a bricklayer of sufficient powers of coördination to lay bricks with anything like that regularity of performance?

"The precise data that may be obtained from the performances of athletes enables the physiologist to place his subject on a level with the exact sciences. And to obtain this reliable data, extreme accuracy in timing instruments, of course, is absolutely essential."

The start is recorded electrically, the resulting graph, as shown below, showing more accurately than a human timer and a split-second watch whether the runner "beats the gun." The photo shows Jack Moakley (left), Cornell track coach, starting assistant track coach Bangs, who is carrying a magnetized steel strip tied around his waist. Moakley holds an electric switch in his hand, which signals the start

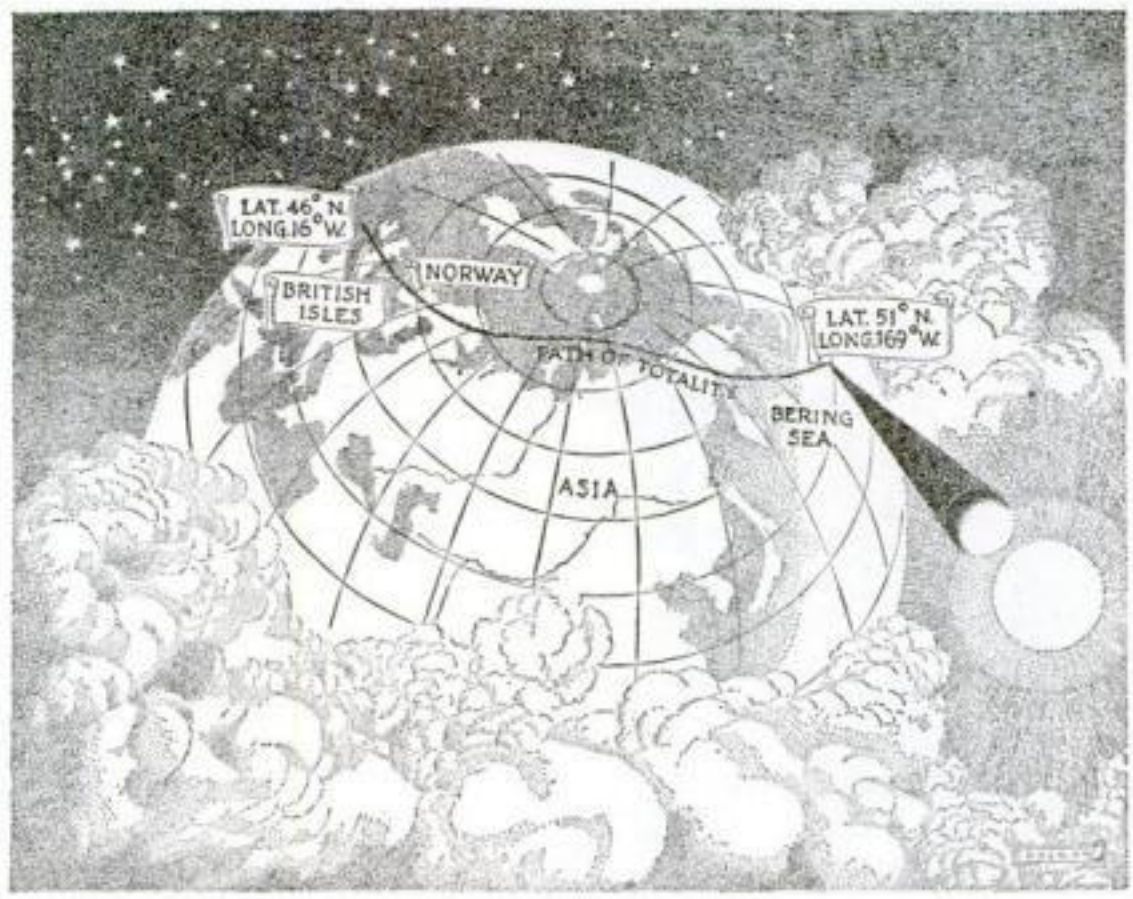


Irregularities in a runner's start are readily detected by a study of the graphs produced by Professor Hill's timing apparatus. These records showed a correct start (upper curve) and a "jumping the gun" start

Sun's Next Eclipse on June 29

ASTRONOMERS from all over the world are gathering in Norway to view the total eclipse of the sun that will occur early in the morning of June 29. The United States, where memories are still vivid of the eclipse of January 24, 1925, is to send at least one party to study the eclipse, the McCormick-Chaloner expedition from the University of Virginia.

The June 29 eclipse can be viewed in Wales, England, Scandinavia and Siberia. It will be the first total eclipse visible in England in 200 years. Special trains will carry Britishers to the best points of vantage in the country, where, a few minutes after sunrise, they will see the sun blotted out for nearly half a minute.

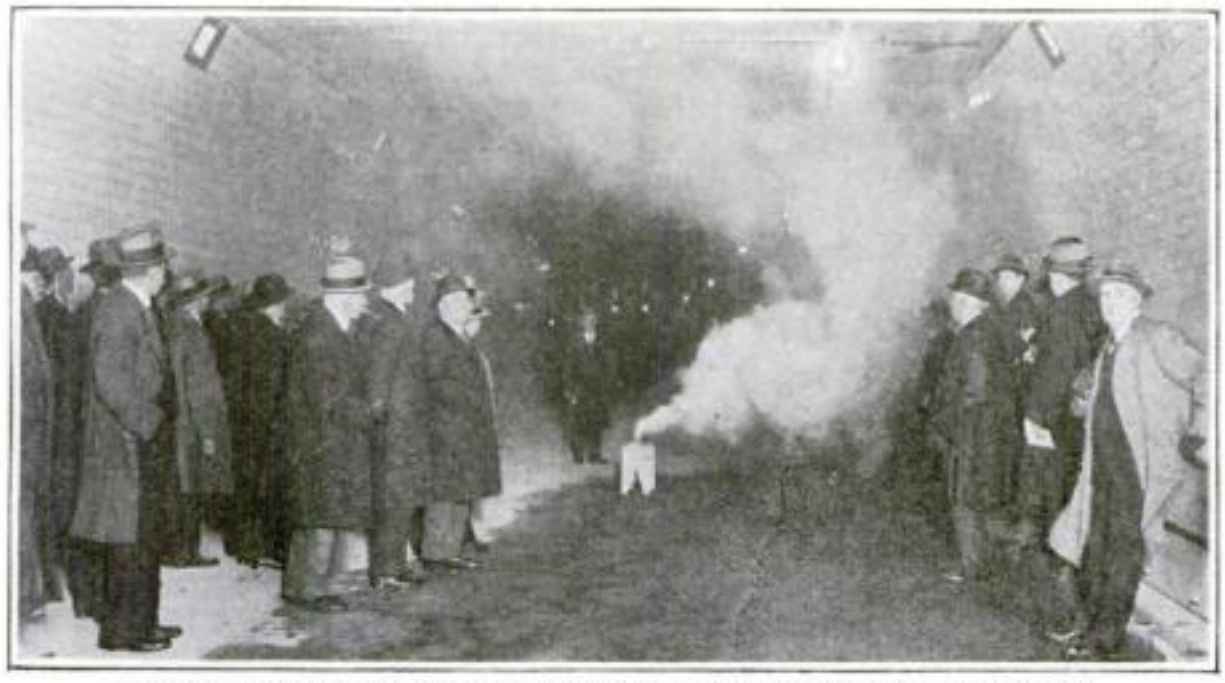


Path of the total solar eclipse to occur June 29, when the moon will pass between sun and earth. Traveling at fifty miles a minute, the moon's shadow will start the eclipse on the Atlantic Ocean at sunrise, sweep across Britain, up Norway, into the Arctic Ocean and through Siberia. It leaves the earth at sunset, having taken two hours to flit across the earth

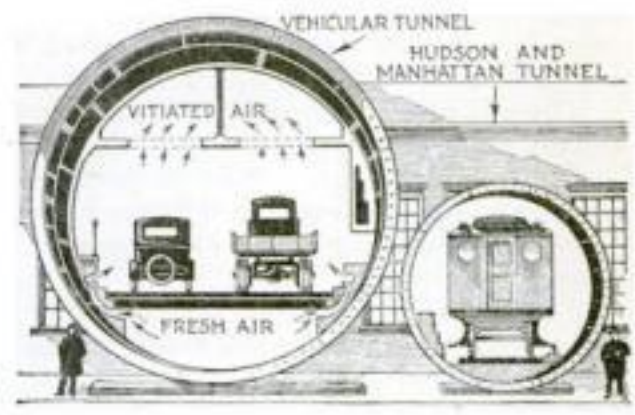
Three other eclipses are scheduled for 1927. The first, a total eclipse of the moon, will be visible throughout this country early in the morning of June 15. Another total eclipse of the moon and a partial eclipse of the sun are due in December.

Scientists find their reward for eclipse expeditions in studies and photographs of the sun's outer atmosphere that could be made at no other time. The American expedition, for example, hopes to reveal new secrets of the mysterious chemical element "coronium," thus far detected only during total eclipses in the hot gases surrounding the sun.

Great Hudson Tunnel Undergoes Health Tests



Watching a ventilation test of the under-Hudson tunnel, made with smoke bombs

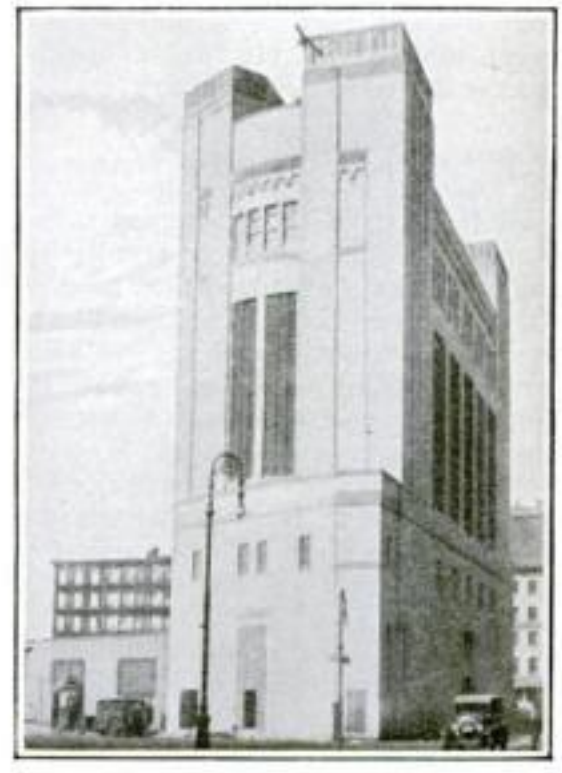


THE ventilating system installed in the new Hudson River vehicular tunnel connecting New York and New Jersey has been, perhaps, the most important of the stupendous problems involved in this great engineering feat. If the ventilation is not adequate in a tunnel designed to carry motor vehicles, there is a possibility of serious injury to the health of drivers using the tunnel.

To solve it, the engineers abandoned the usual scheme of forcing air in at one end and sucking it out at the other. Instead, they made ingenious use of the space at the top and bottom of the circular tubes, as shown in the drawing at the upper right. At frequent intervals along the tunnel, fresh air is forced in from a duct beneath the roadway. Impure air and the deadly carbon monoxide gas produced by the running motors are supposed to flow into the upper duct and out of the tunnel by way of enormous stacks in the ventilating buildings, one of which is shown at the right.

Smoke bombs and smoke candles are being used to test the flow of air in the tunnel. By this means it is possible to get visual proof of just how rapidly the ventilating system will remove the exhaust gases of motor vehicles.

At this writing several tests have been made. Engineers are now checking the results, and expect them to show the tube safe before it is opened to the public—probably in August of this year.



Ventilating building on New York side housing fans that purify the tunnel air. Above, the new tunnel, 29½ feet in diameter, compared with Hudson railway tube

The World's Progress *in* Science

On these pages are presented each month brief stories of scientific discovery and research having practical bearing on our everyday problems.

No "Criminal Type," Survey Shows

THERE is no such thing as a "criminal type," we are now told. The average criminal is a normally intelligent individual, and consequently our methods of punishment, which are based on the theory that he is a "type" and not an individual, are doomed to failure.

Such are some of the findings of the most comprehensive study of a large group of criminals ever undertaken, when the personal and family history, environment and characteristics of 3,053 offenders in the New York Court of General Sessions were studied recently by psychologists and physicians under the supervision of Edwin J. Cooley, professor of criminology at Fordham University. Professor Cooley, who is also Chief Probation Officer of the Magistrates Courts of New York, offers the following conclusions drawn from his investigation:

"Mercy bullets" that stun instead of kill will be used by Capt. Barnett W. Harris, of Chicago, to capture wild animals. An anaesthetic within the bullets, which can be fired from shotgun or rifle, renders the animal temporarily unconscious. Two types are shown in the photo at the left

There is no single cause or combination of causes for crime; there is no such thing as a "criminal type." The majority of criminals are of normal intelligence, not feeble-minded. Environment alone is not a cause of crime.

The real cause of crime, the investigation seems to show, is to be found in neglected and untrained youth. Of the 3,053 criminals studied, 44 percent were under 21, 62.8 percent under 25.

Extension of the probation system and segregation of nonreformable criminals are recommended in the report.

Relics of Ice Age Americans—?

ARCHAEOLOGISTS, digging into the soil of America, have recently come upon fascinating evidence that men lived on this continent far earlier than has been generally believed—perhaps a million years ago! This evidence, gathered by J. D. Figgins and Harold J. Cook of the Colorado Museum of Natural History at Denver, consists of arrowheads and other implements found buried with the fossil bones of extinct animals in ancient geological deposits in Oklahoma, Texas and New Mexico.

The Indian is thought to have first come to America from Asia between 8,000 and 25,000 years ago. The newly found relics, however, are believed to date back to the great Ice Age, when northeastern America was covered periodically with an immense glacier and when prehistoric elephants and mastodons roamed the land. This was 25,000 to a million years ago.

Mummies unearthed from the burial caves of ancient "Basket Makers" in Arizona have revealed that the American woman who lived about 1500 B.C. bobbed her hair. Her husband let his hair grow long, and braided it. Buried with one prehistoric woman was the mummy of a small lap dog!

New Anaesthetic Tested

DISCOVERY of a new anaesthetic, said to have important advantages over ether or chloroform, is claimed by German surgeons. Known as "107," it has proved successful in 300 tests, according to Dr. Ernst Unruh, of Berlin.

Under its influence, pulse and blood pressure of patients are said to remain normal, disagreeable after-effects and danger to heart, lungs or nerves eliminated, and operations possible even in severe cases of pneumonia and advanced tuberculosis. Since it requires no inhalation mask, it permits operations on the face, nose and throat. A bromine solution, "107" is introduced into the intestines.

Rubber Chemistry Magic

WE SHOULD find it hard to get along today without rubber; yet its countless uses would have been impossible without the ceaseless work of chemists. Dr. W. C. Geer, one of America's foremost rubber experts, recently stated that the world owes a billion dollars a year to chemistry in the rubber industry alone.

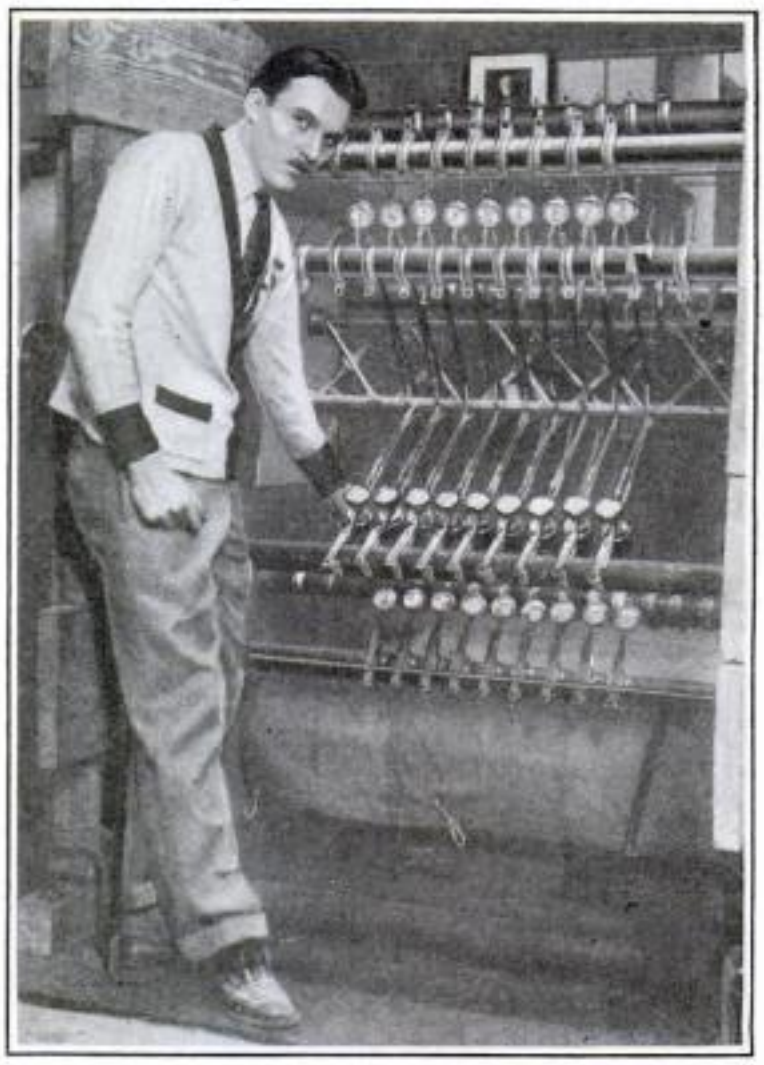
This billion is represented in the production of better rubber by speedier processes. Our automobile tires, golf balls, garden hose and gloves last twice or three times as long as they used to. New chemical processes have almost entirely cured the tendency of rubber articles to become hard and dry with age. In fact, but for the chemists, says Dr. Geer, the world's supply of rubber would have been exceeded long ago by the demand.

High Wages Boost Inventions

INVENTION of labor-saving devices in industry is being more than ever stimulated by the decrease in the supply of "cheap labor" in this country, says Prof. Robert D. Ward, of Harvard University.

"From one end of the country to the other, reports of new labor-saving machinery are coming in almost daily. New coke-handling apparatus, mechanical brick makers, track layers, and numberless other machines are replacing crude hand labor and at the same time saving money. The question, 'Who will dig our ditches?' is answered by mechanical ditch diggers, the largest of which can do the work of four hundred men!"

The rapid development of new machines to do rough work is not only decreasing unemployment, Professor Ward



Tests are still being made to solve the mystery of the destruction of the dirigible *Shenandoah*. Above is a machine devised at the Bureau of Standards to test girders made by the same process as the *Shenandoah*'s, to discover whether structural weakness caused the mishap

"Mercy" Bullets for Animals—Alcoholism in Rats—Dancing Measured in Calories—New Anaesthetic, and Other Discoveries

finds, but is smoothing out the peaks and hollows of seasonal employment. He prophesies that the new industrial situation, while increasing labor costs, will nevertheless lower production costs.

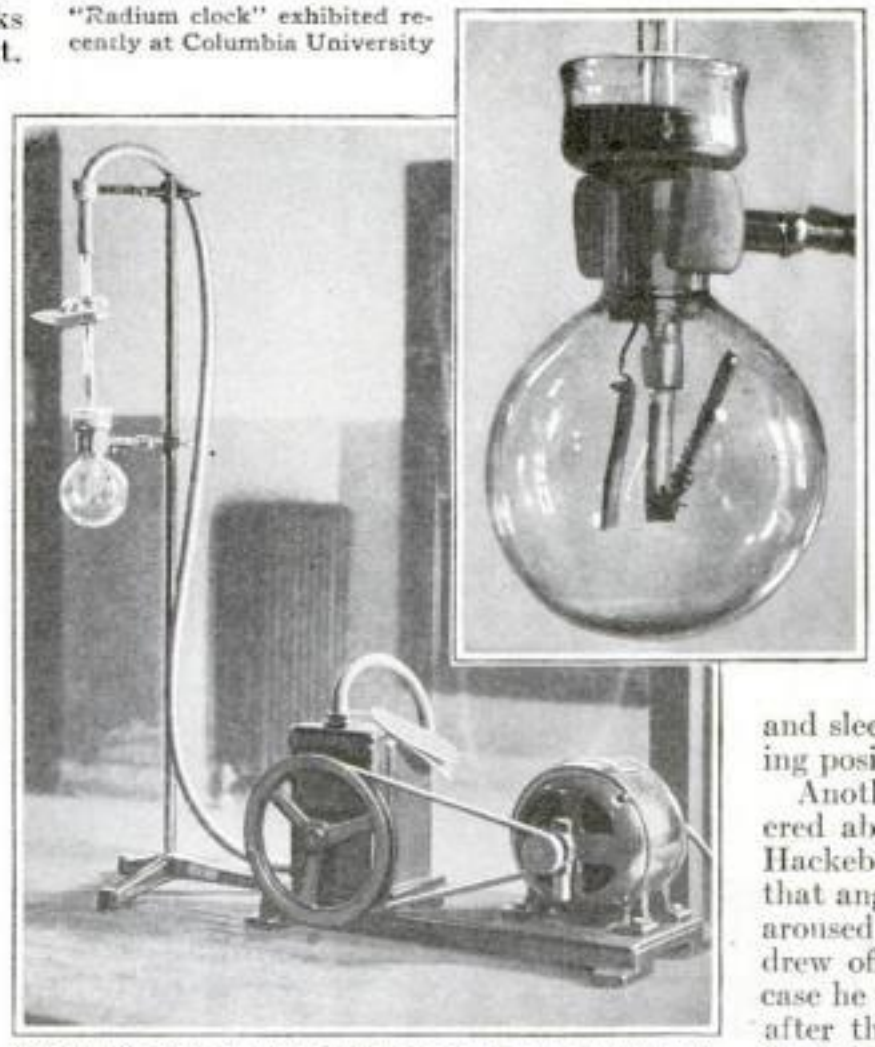
Twins Alike Even in Unlikeness

NO TWO things in the world are exactly alike, we are often told. A close approach to duplication, however, is found in the case of "identical" twins; that is, twins believed to have grown from the same fertilized egg cell, as distinguished from ordinary or "fraternal" twins. Recently a Japanese biologist, Dr. Taku Komai, reported the results of studies which show that in some instances twins actually may be more like each other than are the two halves of a single individual. For example, the right hand of one identical twin resembled the right hand of his brother more closely than did the right and left hands of either twin!

How Dances Burn Us Up

SCIENTISTS at the University of Helsingfors, Finland, have just completed interesting measurements of the energy consumed in dancing, in terms of heat units. The fast mazurka consumed the most fuel—10.87 calories an hour for each kilogram of body weight, or almost twice the energy consumed by a stonecutter plying his trade. The polka required 7.56 calories; fox trot, 4.78; schottische, 4.76, while the waltz used up the least energy, 3.99.

"Radium clock" exhibited recently at Columbia University



Radium "tells" the time, in this amazing new instrument. Within a vacuum bulb, an electrically charged gold leaf "pendulum" swings alternately back and forth each half minute under the influence of the alpha rays of the radium. A high vacuum is obtained with a motor driven pump

Science and Conservation

REGARDING future development of natural resources, Secretary of the Interior Hubert Work says: "Science can help us find new wealth in materials trodden under foot as worthless."

A dirty yellow mineral found on barren slopes of Colorado proved to be radium, boon to the suffering. Helium gas was found in natural gas from Kansas wells. Today it is being used for inflating airships, for cooling electric generators and motors and filling radio tubes; in the treatment of disease; even to make toy balloons safe for children!

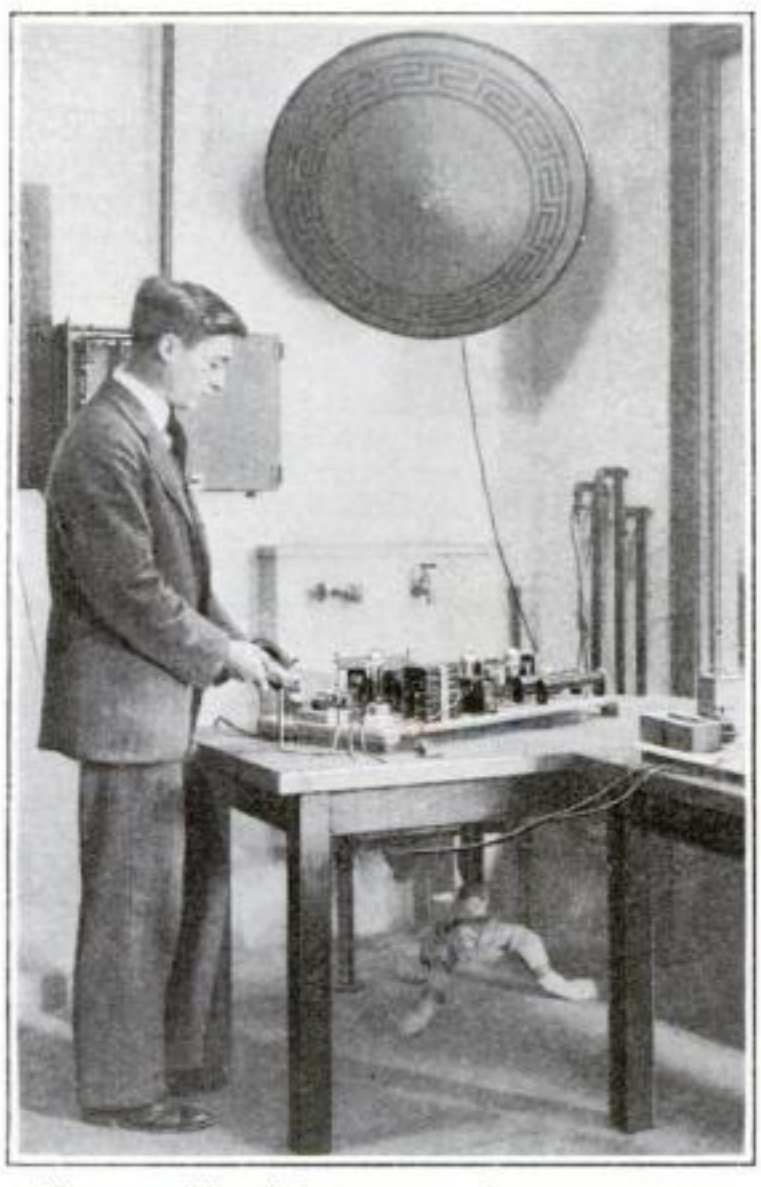
Priceless wealth lies hidden all about us.

Blood Has Daily Tide

IN THE blood stream, pumped from the heart to give us life, there are daily tides, like the ebb and flow of the tides of the sea. Dr. A. F. Bernard Shaw, of Newcastle, England, recently made this discovery while studying the white corpuscles of the blood. These white cells, whose duty it is to fight disease germs which enter the blood, are known to vary in numbers from time to time. Dr. Shaw found that the number increases and decreases in two regular daily waves.

The high tide of white corpuscles usually comes just after midnight, and again in the afternoon. Dr. Shaw suggests that these tides may bear some relation to the hours of eating and sleeping, or may be due to changing positions of sun and earth.

Another strange thing just discovered about our blood by Dr. W. M. Hackebusch, German physician, is that anger makes it turn sweeter. He aroused anger in human subjects, then drew off samples of blood. In every case he found more sugar in the blood after the fit of emotion than before. Now he offers it as his belief that anger is nature's way of preparing the body for combat. More sugar in the blood immediately supplies food for the muscles to act quickly.



Science now "hears" the atom, too. By means of this remarkable device, invented in Germany, the movement of millions of atoms in a bar of soft iron, when disturbed by a magnet, can be heard distinctly as a peculiar roaring

Alcoholic Rats and Heredity

JUST because a person is descended from hard-drinking ancestors is no sign that he can "hold his liquor" better than others; nor does it mean he is more likely to turn into a drunkard. Such are the conclusions of Prof. Frank B. Hanson and Miss Florence Hays of Washington University, St. Louis, Mo., after staging a series of drinking tests with rats.

In a tight box they placed ten rats, five of which were descended from ten generations of drunken ancestors and five from sober forbears. After saturating the air in the box with alcohol fumes, the experimenters observed the time it took the animals to keel over. Repeated tests showed virtually no difference in their resistance to the drug.

More Antennas, Weaker Signals

AN INTERESTING new fact about radio broadcasting has been revealed by R. H. Barfield of the English Radio Research Board. It is this: The strength of a signal received on your set depends materially on the number of other radio listeners tuned in. In other words, every additional antenna takes energy from the broadcast signal.

By testing waves received from the same station in various directions, Mr. Barfield found that the energy, after passing over districts with many antennas, was noticeably less than after passing sparsely settled regions with few antennas.

THEY took turns pumping the bellows of their enlarged blast furnace. A month after landing, almost naked, on that desolate spot, they had manufactured out of the island's raw materials more than a ton of iron!

Bare Hands

Illustrated by J. Clinton Shepherd

Science and Ingenuity Put to the Supreme Test

By HAWTHORNE DANIEL

CRUISING among the Aleutian Islands, four Seattle yachtsmen—Parker and Thornton, partners in an engineering firm; Williams, a young naval architect, and Kelly, a deck hand—were captured and imprisoned in their own yawl by Kiska Joe, murderous half-breed seal poacher. A shipwreck separated them from their captor, but cast them with Oomak, one of Kiska Joe's crew of native Aleuts, on the desolate shores of Devil Island. By killing game they supplied themselves with food and clothing, and by smelting ore found on the island they made tools of steel. A weird cry that echoed through the island mystified them, for they could find no trace of inhabitants. They planned to build a boat to be driven by a steam engine fashioned from iron ore. But just as they were beginning work on the boat, Kiska Joe's schooner appeared offshore. He had returned to search for them. When the poacher reached the beach in a small boat, Parker, overjoyed at the chance of rescue and acting against the advice of his comrades, hurried to greet his former captor. He was immediately seized and bound. Kiska Joe and one of his men, armed with rifles, then advanced against the other castaways who lay concealed behind rocks at the top of a cliff. As Kiska Joe drew near, Kelly rolled a boulder down upon him. Now read on:

A BRANCH snapped as the boulder fell, and with the quickness of a mountain goat Kiska Joe leaped. He was none too soon, for the rock crashed within five feet of him, then bounded down the ravine until it splashed into the stream. Even before it came to rest in the water, Kiska Joe lifted his rifle and fired four shots in rapid succession in the direction from which the boulder had fallen. Kelly heard the bullets spatter on the rocks before him.

"Well, he knows we're here," whispered Thornton. "He may not come any farther."

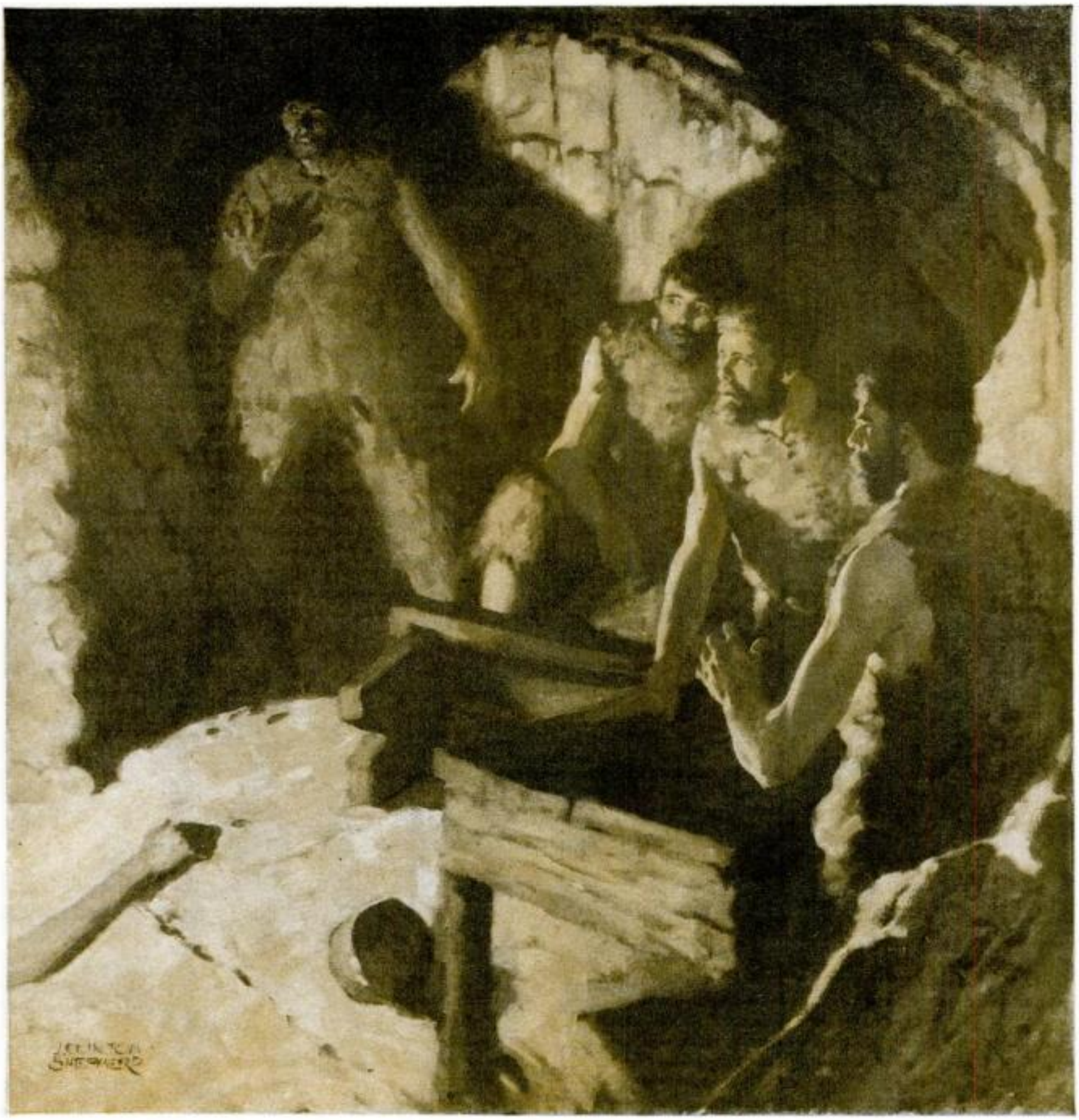
But Kiska Joe was not to be frightened by a single stone. Again he started forward, keeping well to the other side of the ravine. Thornton raised his head a trifle to see where their enemy was, and a bullet clipped the leaves close to his ear. Kiska Joe had dropped the packages he had been carrying, and now was ready to fire at any movement he could detect. His follower, too, stood ready with his rifle.

The group of castaways at the edge of the ravine were in desperate plight. They could not fight, except with stones, and the two attackers now were well beyond the reach of stones. Retreat was the only thing left, and they began silently to creep away. Hardly had they started when they were frozen in their tracks by a shrill, unearthly cry from far down the ravine. It came nearer. They stood listening. They had heard that sound before.

OOMAK began to whimper. They heard Kiska Joe and his follower cry out, then the sound of hurried footsteps. And when the group above the ravine approached the edge once more the two poachers had disappeared. The cry, too, seemed now to be moving away. They could not tell what it was, but obviously it was the same sound they had heard that first day on the island. They looked once more down the ravine, but nothing was in sight. Obviously, Kiska Joe had fled. Reaching the cliff edge, they gazed out across the beach.

The schooner still lay at anchor a mile away, but the boat had left the beach. Kelly made it out as it was being hurriedly rowed toward the schooner. They saw it go alongside, and saw four tiny figures climb on deck. Plainly Parker was with them, a prisoner. But why had Kiska Joe fled from the cry? And what had made the sound? Oomak was the only one who tried to explain it. He wished now that he had risked Kiska Joe's anger, for at any rate Kiska Joe was a man, and this thing that shrieked about the island—well, these white men could say what they pleased, but *he* knew, and knowing, he was afraid.

It was a downcast group that assembled in the cave that



There was a cry. A body fell to the ground. A hand reached through the door and lay with its fingers outstretched in the firelight. The men about the table leaped to their feet

evening. They blamed themselves for Parker's capture. What would happen to him, they could not guess. Furthermore, they suspected that Kiska Joe might take it into his head to land again sometime, to surprise and capture the rest of them.

They realized they would have to guard against a surprise attack, and so for the next week they labored at erecting, across the narrowest part of the ravine, a barricade that would prevent anyone from coming up their path. They made a ladder for their own use, and kept a constant lookout lest Kiska Joe should come upon them unobserved. It was while they were working on the barricade that they discovered the packages Kiska Joe had dropped. One was a ham, which they pounced upon with delight. The other was a small bag of dried beans. Both, apparently, had been intended as offerings to the spirits of the island, but they were welcome additions to Oomak's larder.

Having completed the barricade, they made a circuit of the island, and found two other places where routes led up the cliff to the high table-land. One of these they were able to break down, for it was merely a pile of tumbled rocks that formed an irregular series of steps. But the other could not be destroyed, and they had to content themselves with cutting small trees and brush, and covering the place, hoping that thereby it would escape discovery.

Furthermore, in the evenings Thornton busied himself with making four wooden guns, which he blackened with charcoal.

"Not much good for offense," he explained when Williams laughed at him. "But once we get behind our barricade, they may make a showing that will keep Kiska Joe back."

"Couldn't we make gunpowder and real guns?" asked Kelly, whose admiration of Thornton had grown to the point where he thought the engineer might be able to construct anything.

"IF YOU'LL find some sulphur and saltpeter we'll do it," nodded Thornton. "But I'm afraid they aren't here. Anyway, we don't need firearms. We can line the edges of the ravine with boulders, and if anyone tries to come up we can roll them down, and they can't get past our barricade."

It was a week to the day after Parker's capture that they resumed their work on the boat. Within a few days the logs were all split and laid out where the sun would shine on them. In that time Thornton had planned their program.

For a week they made charcoal, until they had a huge pile beside their blast furnace. Next they made two litters on which to carry ore, and pressing Oomak into service, they made trip after trip, hauling about two hundred pounds of ore at a time. Their method of weighing it was simple. Thornton weighed one

The lathe, driven from the water wheel by a belt of sealskin, was made with wooden shafts, pulleys and bearings

hundred and ninety pounds, and so, having placed him on a litter, they lifted him, and then tried to approximate his weight with a load of ore.

"How much will we need?" asked Williams. "And how can you tell?"

"We can't tell exactly," replied Thornton. "But this ore is rich. Judging from the amount of metal we got from the ore we smelted before, it should be about seventy percent iron. In other words, nearly three hundred of each four hundred pounds of ore is iron. Of course, the way we have to do it, we can't get that much out of it. But suppose we get fifty percent. Then, if we want two thousand pounds of iron and steel, we will need two tons of ore. To be safe, we better have more. We may ruin a lot of it. Let's take thirty litter loads. That ought to be enough. If it isn't we can go for more."

SO THEY carried thirty heavy loads of ore and piled it beside their furnace, and then devoted a day to breaking it up into small pieces. Nor was that all. They found a small bed of limestone.

"Fine," cried Thornton when Williams came in with a bit of the stone. "Fine. I didn't think it would be here. It's probably the deposit from some old dried-up hot spring."

"Huh!" grunted Kelly. "Do we have to carry a lot of that stuff, too?"

"You bet we do," replied Thornton. "But not so much of it as we carried ore. That's something to be thankful for."

After two weeks spent in making charcoal, and in carrying ore and limestone, they were ready, once more, to start smelting.

"We'd better repair the furnace," suggested Thornton. "We don't want to stop, once we have it started, until we've finished the job."

So, while Williams complained and Kelly grumbled, they cleaned out the chimneylike affair, enlarged it, made larger bellows operated by jointed sticks arranged something like pump handles, and at last filled the furnace with kindling, charcoal, ore, and limestone.

"Now for pig iron," said Thornton. "We can't cast as we go, so we'll have to remelt the metal once we get it." He thrust a burning brand through the cinder notch to ignite the kindling, and leaving Williams and Thornton to pump the improved bellows, he set about digging a series of complicated ditches in the sand, with little channels leading to small oblong pits two or three inches deep.

"What's all that for?" asked Kelly, pumping until the flames shot out of the stone furnace.

"To make pig iron," replied Thornton.

"Pretty small pigs, don't you think?" asked Williams.

"Done purposely," returned Thornton. "We can't handle big ones."

Within an hour the molten metal began to collect in the bottom of the furnace, and after another hour Thornton broke the clay stopper and let it run forth. He watched it carefully to determine just how rapidly it was collecting on the hearth, and enlarged the hole from which the molten metal ran until he regulated the flow almost to balance the speed at which it was collecting. Using crude wooden shovels they had chopped out with the adze, they kept the little furnace filled with the three essential elements. They took turns pumping the bellows, shoveling, and watching the flow.

Thornton directed the flowing iron into set after set of the crude molds, building little dams of sand across his main channel, tearing them out and rebuilding them farther down. All day they worked and on into the night. The morning sun rose again before the last of the stream trickled from the caked spout and the worn group went to their cave and threw themselves upon their beds.

It was done. A month after landing almost naked on that desolate spot, they had manufactured out of the island's raw materials more than a ton of iron!

Early the next morning they were ready once more to renew their labors; yet almost at once they were confronted by a new and puzzling mystery.

Oomak had set about getting breakfast, and first looked for the axe, to split some wood. It was gone. At first they did not take the loss seriously, and then Oomak suddenly discovered that the piece of ham they had not eaten had disappeared as well. It was only when they began a systematic search that they found the one sign that had been left behind. On a smooth rock a dozen feet from the door of the cave was a crude drawing done with charcoal. It had not been there the night before, for on that rock Kelly had sharpened the adze, and Williams had rubbed the axe blade. It was a wild and very crude drawing of a bird with a huge beak—with great round eyes—with powerful wings—drawn in full flight. It was not unlike some of the strange birds that surmount totem poles.

Oomak's eyes grew wide when he saw it, and he blanched beneath his swarthiness.

"The devil come to kill us!" he cried. "It is the sign. It mean we die—we have enemy—devil, maybe. It is the sign!"

That someone was on the island beside themselves they felt certain now. Still, though they made another entire circuit of the island near the shore line, they were unable to find a sign of any other inhabitant. So they returned to their tasks, determined to guard themselves and their possessions even more carefully than before.

They decided upon a division of labor. Williams and Kelly built a little dam across the stream and erected a water wheel, while Thornton constructed a lathe. Oomak, in the meantime, surprised two more seals on the beach, and killed them. The skin of the first one, removed whole, was nearly half full of seal oil. The Aleut wanted one of them for an offering to the devils of the island, but the others refused. Instead, the two skins were tanned after Oomak had scraped them clean with his obsidian knives.

THE lathe, driven from the heavy water wheel by a belt of sealskin, was a roughly built contrivance, made with wooden bearings, wooden shafts, wooden pulleys, and a wooden frame. There was little metal in it except nails, rivets, chuck and spindle. But it worked, and on it Thornton made an improved set of wooden shafts and bearings to replace the ones hewn by hand. Then he forged a shaft of metal on an anvil they had cast, and after placing the forging in the lathe as he would have placed a piece of wood to be turned, he managed, after two days, to get it turned down with the tools he had made and by using sand and stone as abrasives. *(Continued on page 133)*

A Wonderland of Science

Amazing machines seen at Popular Science Institute of Standards that guard you in buying tools and radio equipment

By

ALDEN P. ARMAGNAC

Talking over the results of a loud speaker test—Prof. Collins P. Bliss, director of Popular Science Institute of Standards (left), and Alexander Senauke, radio engineer

TWO thousand men pulling on a hammer handle! Corrugated with massive gears, a huge wheel turns slowly, almost imperceptibly, but with inexorable force! A mechanical hand two thousand times stronger than mine—pulling on the handle of a hammer the claws of which clutch the head of a heavy wire nail. The nail itself is clinched to the bed of the machine. Yet the mechanical hand pulls the nail with childlike ease! That sight met my eyes as I entered the laboratories of the Popular Science Institute of Standards. Two engineers were bending over the machine that trapped my attention. They were measuring a strange thing—the grip of a hammer's claws!

You or I might buy a hammer like that. Would we grasp a nail with it, only to see the nail slip through the claw? Wait a moment—over the round dial, a needle flickers. The nail writhes free from the machine's base, and the gears stop. The hammer's claws, holding the nail with a viselike grip, passed the test.

Next, will our hammer head stay where it belongs? Is its face tough and durable? Will the handle break? Like a carpenter's arm, but made of steel, another machine pounds the hammer on an anvil ten thousand times, trying to dent its face or loosen its head. Then a plunger squeezes a tiny, hardened steel ball into the head with terrific force to test its hardness. Last, the handle is deliberately broken.

Did you ever break a hammer handle, tugging on a balky nail? Back goes the hammer to the first machine. This mechanical hand pulls on the hammer handle while the tip of the claw clutches a husky bolt—that can't let go! Something will have to break. The gears revolve. The needle swings downward. The handle creaks under the mounting strain. Snap—the hammer lies useless, its handle broken in two. How much strain did it take?

More than two hundred pounds on the ten-inch hammer handle registered on the dial as the hammer broke. When a 150-pound man hangs on a hammer with all his weight, he gives it all the punishment a good tool should be able to stand. This hammer did better. If you bought one like it, you need have no fear that it might fail you, for these tests, completed in a few minutes, have given it as severe treatment as it would get in years of everyday use.

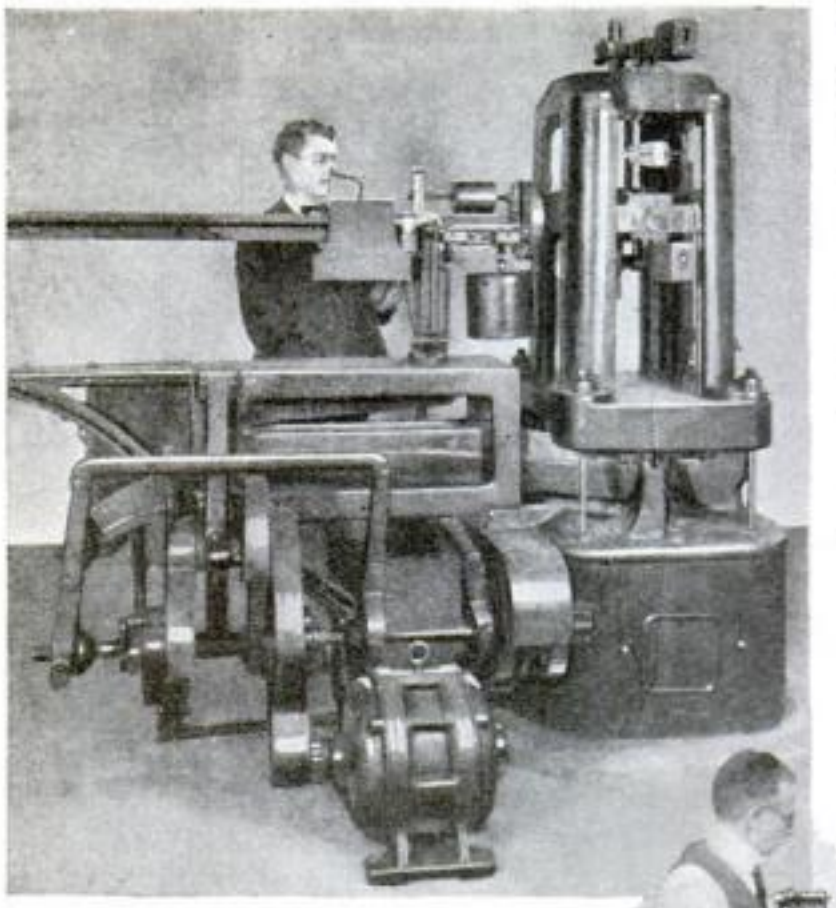
How hard are the plier jaws? C. T. Schwarze of the Institute staff is conducting this test. All tools are tested by machines simulating human handling, and every tool passed is guaranteed

At no other laboratory in the world are there such tests. They have been invented to simulate as closely as possible the way you or I might handle a hammer. The machines are as nearly human in their movements as scientific ingenuity can make them.

In these amazing laboratories are machines to test almost every kind of tool and every type of radio apparatus. And each of these tests is just as thorough as that for a hammer. These tests were established to protect you and me in our purchases of apparatus of a technical or semitechnical nature; to tell us whether the radio set, the loudspeaker, or the tool we buy is a good one; to substitute, for guesses, scientific tests of hairbreadth accuracy.

In the radio laboratory, for example, novel tests supplement examination of a radio set's parts. Before a set has emitted a single sound, institute experts can tell you just how well the outfit will reproduce a speech, a string quartet or a brass band.

Absolute silence filled the room. The immense loudspeaker on the wall was mute. Alexander Senauke, radio engineer, was testing a receiving set. Only quivering indicators on the electric dials of his instrument betrayed the source of the figures he was jotting down. Yet with these figures he traced a curve on a sheet showing at a glance the tone quality of that particular set. He knew definitely and accurately whether it would give you a throaty gurgle and an unintelligible distortion of the human voice, or a faithful reproduction of the music and voices that its antenna brought to it.



A giant testing machine at the Institute crushes the jaws of a bolt clipper as easily as if they were cardboard—a scale measures the force

Signals to test radio receivers come from a miniature broadcaster right in the laboratory. Outside signals might vary in strength and spoil the tests. But here is a transmitting station under instant control, that produces a radio wave to correspond to any desired component of an orchestra or human voice. Popular Science Institute tests for radio equipment, Mr. Senauke told me, are the most complete in the world.

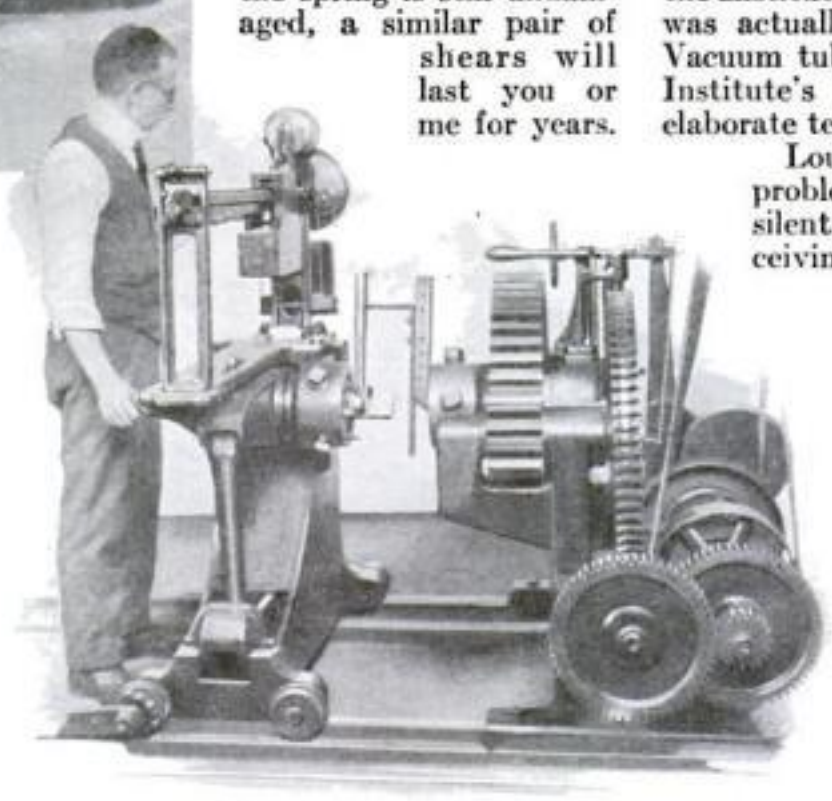
Every day the engines of these laboratories answer scientifically the layman's questions: "How well does it work? How long before it wears out?" Every day brings new problems, problems for which they must invent new tests.

There was the manufacturer, for instance, who was trying a new steel for the shank of his spiral ratchet screw driver. He came to the Institute's tool laboratory and asked how long the groove in his new tool would last. The wear on the groove, twisting the screw driver in response to a straight push on the handle, depends on the pressure of thrust. To test the hardness of the steel used in the tool was easy. But the manufacturer expected the Institute to tell him just how long the tool would last. So a new test, a test for spiral ratchet screw drivers, was invented.

THE Institute engineers, therefore, drove into an oak plank an ordinary wood screw—twisted as tight as a man with a hand screw driver could set it. Then they mounted the block, screw and all, on a rotating spindle. They put on a brake drum, too, with an adjustable brake, and set their brake at a tension that was just a shade more than that required to turn the screw. Then they mounted the spiral ratchet screw driver in a reciprocating machine that thrust it back and forth against the screw on the braked wood block. The screw sank into the wood until its tension equaled that of the brake—then the screw balked and the block spun. From then on, the tension on the screw driver blade was a lifelike imitation of a screw being driven home.

The device was run continuously for several days. At the end of that time, the screw driver had delivered enough strokes to drive forty thousand wood screws! It had had the equivalent of years of heavy everyday usage. And the manufacturer was given the information which he sought.

A versatile device, this reciprocating machine—it tests pruning shears as well. Their weak point is the flat coil spring that opens the blades. A few thousand times open and shut tells the story. If the spring is still undamaged, a similar pair of shears will last you or me for years.



While massive gears revolve, a mechanical hand pulls the hammer, clutching the nail; and so the grip of the claws is determined

Screw drivers and monkey wrenches torn to pieces! A strange machine twists a screw driver to find when its handle will splinter, its point chip, or its shank twist apart. Another clamps a wrench on a square steel bar and then forcibly twists it off, to see what will happen to the jaws.

Thumping machines, pounding machines—that lift a heavy weight a standard distance to let it drop like a pile driver on the tool in their jaws—stand beside giant testing devices. A monster nutcracker smashes bolt clippers and pliers to bits. Other devices run by electric motors twist and pull apart husky bars of the same cold rolled steel that goes into tools. The largest of them has a crushing strength of two hundred thousand pounds!

WHILE these mammoth testing machines are devouring tools in their jaws, more delicate tests go on in the radio laboratory. When B-battery eliminators first appeared on the market, it was at the Institute of Standards that their hum was actually measured and compared. Vacuum tubes and batteries receive the Institute's seal of approval only after elaborate tests.

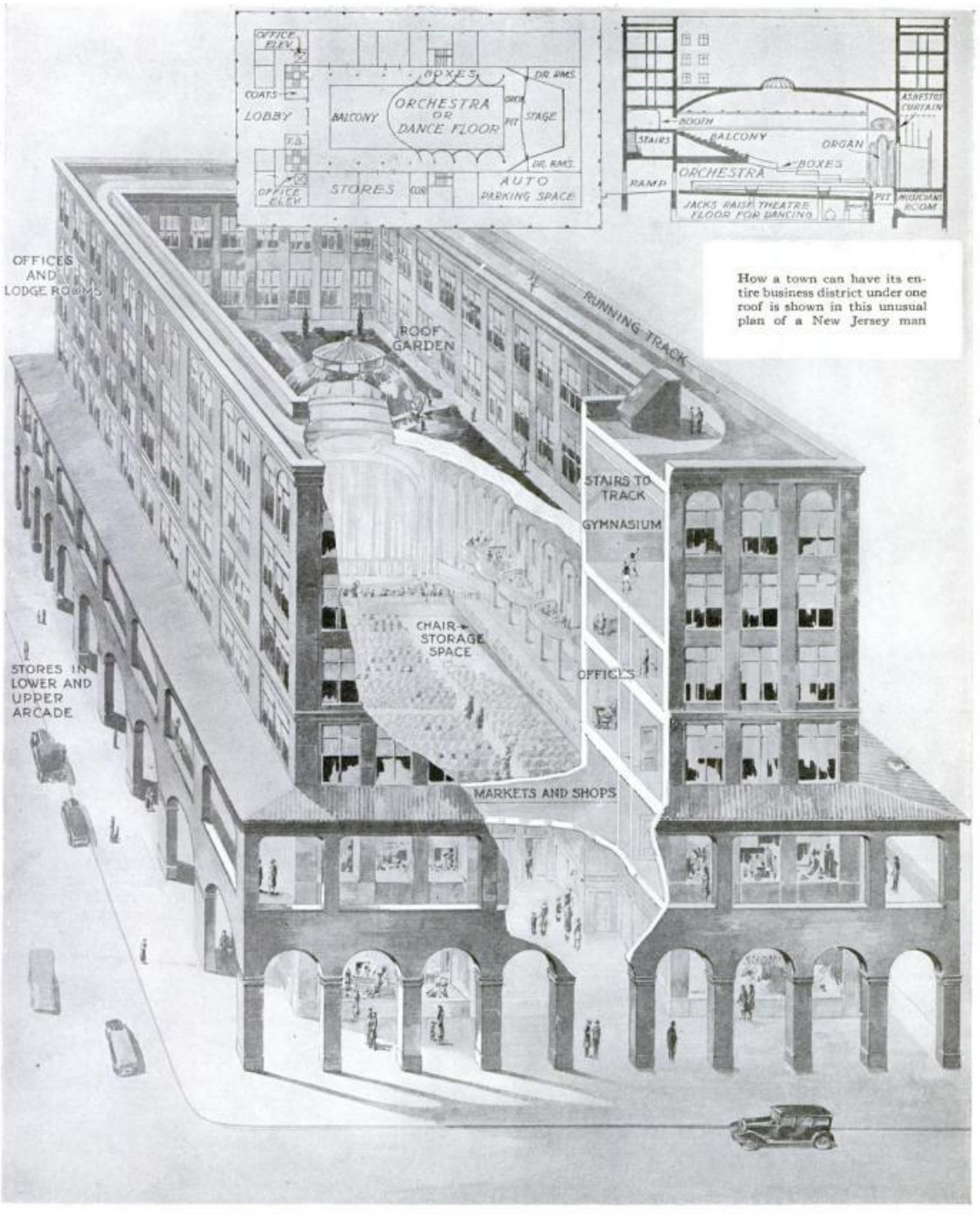
Loudspeakers present peculiar problems all their own. Here the silent testing must cease. A receiving set yields electric impulses that the eye can read on instruments, but a loudspeaker delivers sound alone. How could it be measured?

The human ear doesn't hear all sounds equally well! Just as the eye sees some colors brighter than others, so the ear hears sounds of a certain pitch better than others. A loudspeaker perfect in theory, that shot out all tones equally loud, would not sound uniform to the ear at all!

So the workers at the Institute resolved to find some test that would depend on the ear alone. Telephone engineers, they knew, sidestepped the difficulty with what they called "trans- (Continued on page 140)

Radio sets are tested for every conceivable thing—something no other organization does. This elaborate array of equipment tests the life of batteries under the same usage you might give them

Ingenious New Community Building

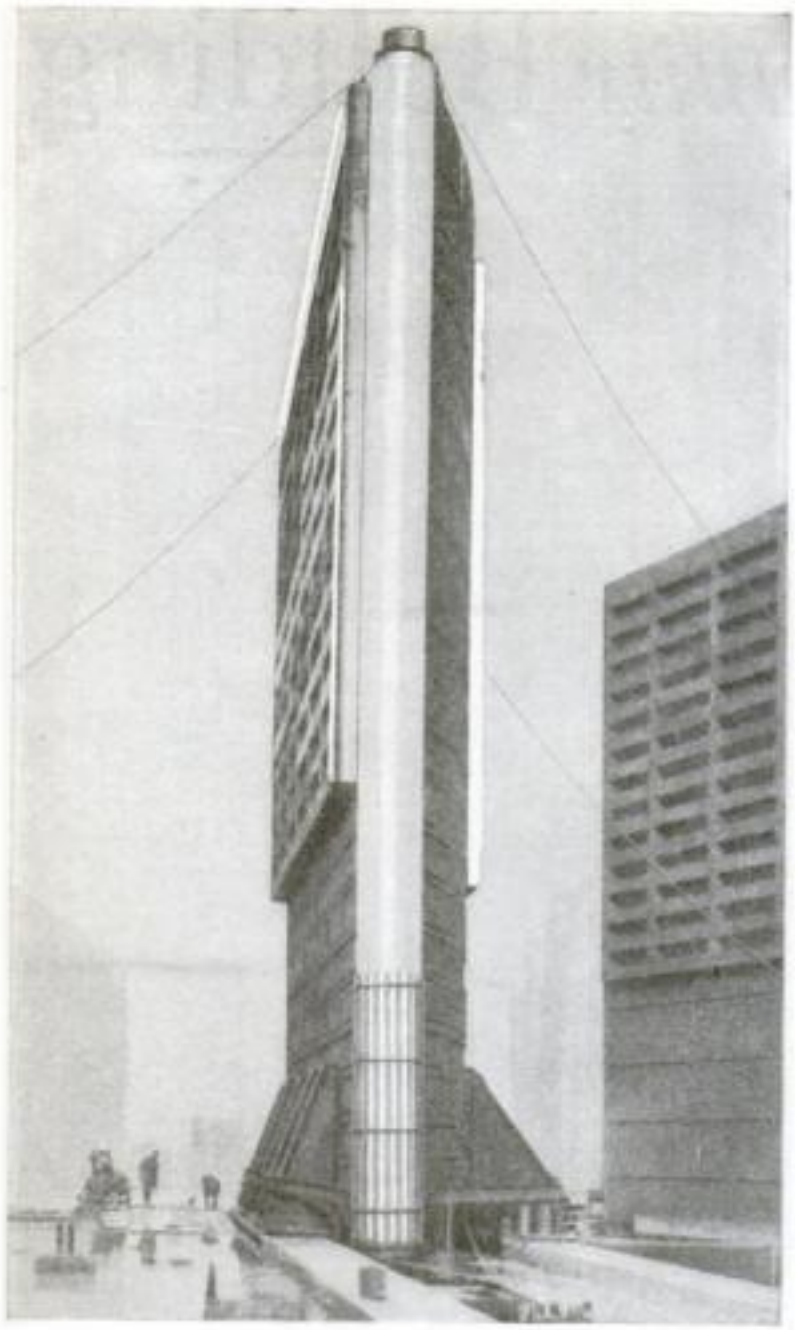


How a town can have its entire business district under one roof is shown in this unusual plan of a New Jersey man

COMBINING under one roof a town's entire shopping, business and theater district, a novel "community building" is proposed by Joseph Falk, of New Brunswick, N. J. Under the plan, a town could transplant its "Main Street" to the inside of this structure and build an attractive residential section around it.

Drawn by our artist from Mr. Falk's designs, the picture shows the huge central theater auditorium, surrounded by two levels of stores. The auditorium is transformed into a dance hall by leveling the sloping floor with hydraulic lifts and removing the chairs. Above are business offices, lodge rooms, and a roof garden.

Such a building, Mr. Falk estimates, having a 120-foot front, would not cost more than $300,000 to build—a profitable investment in town beautification, repaid as well by the economy of central heating and maintenance. Store deliveries would be made through a single service department.



World's Largest Lock Gate

MORE like a skyscraper in appearance than a gate, this mighty structure is one of the leaves of the lock gate that soon will close the river entrance to Liverpool's new dry dock. When completed, the dock of the great English port will be one of the finest in the world, and this lock gate the largest in existence.

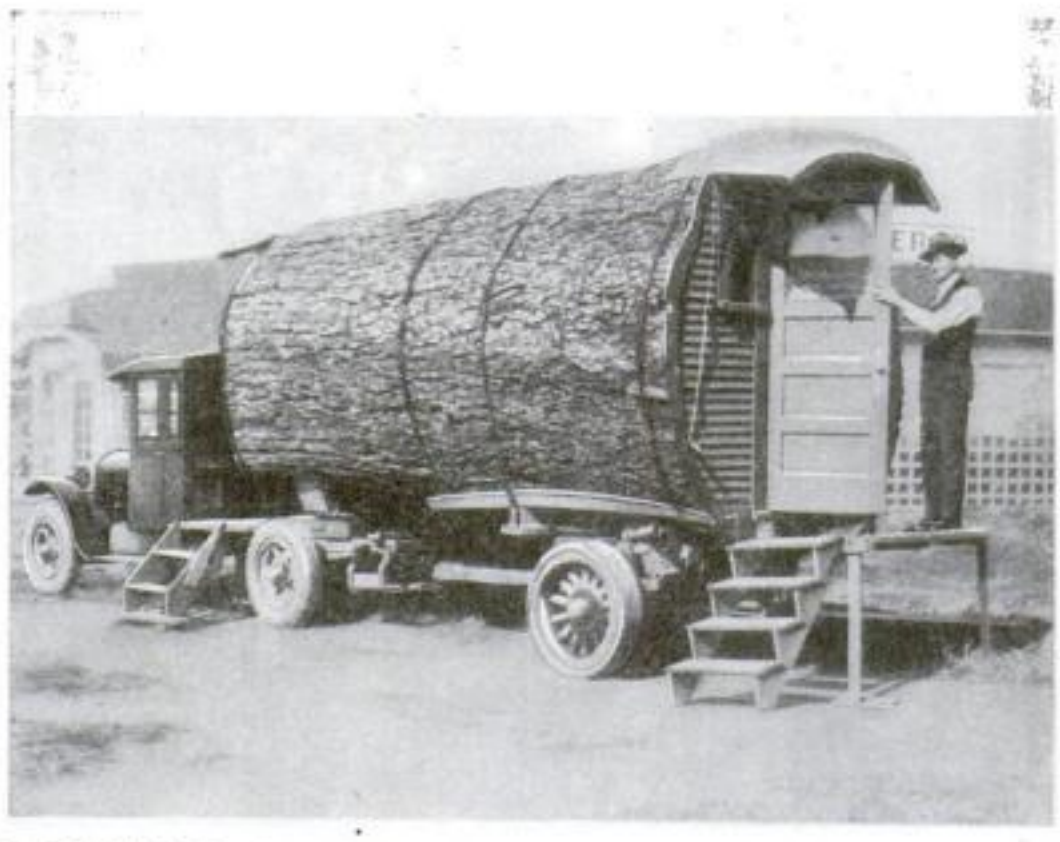
Russia's Superpower Project

RUSSIA will have the largest hydro-electric plant in Europe if plans recently announced are realized. Built on the banks of the Dnieper River, the plant will have a capacity of 630,000 horsepower, surpassed in this country only by Niagara. The Soviet government has retained Col. Hugh L. Cooper, who designed the Wilson dam at Muscle Shoals, as chief consulting engineer for the project. Other projects, of smaller size, will be additional links in Russia's superpower chain.

Beating the Housing Shortage

A PLOT of ground in France—at least in Paris—costs more than an old pontoon boat and the same area of water—so a Paris workman built this neat two-room bungalow, pictured at the right, for his small family on an old boat abandoned along the Seine River. Just now he is anchored opposite the Louvre, museum of art treasures, but when he wants a change of scenery from his bedroom window, he'll cast off and float away to a different location.

Touring the Country in a Tree Trunk



WITHIN the giant, hollowed-out trunk of a Douglas fir, mounted on a motor truck, Mr. and Mrs. E. A. Wade and their son, of California, are touring the country. Their novel temporary home is a modern two-room apartment that contains all the comforts of home—built-in breakfast nook, cupboard, wardrobe, even electric light and an oil stove for cooking. Two beds that fold against the wall provide ample sleeping accommodations. Mr. Wade undertook the tour to lecture on lumber conservation.

New Element Isolated

AFTER a difficult refining process, Drs. Walter and Ida Noddack of Berlin, Germany, discoverers of the new chemical element rhenium, have succeeded in obtaining and testing two milligrams — seven one-hundred-thousandths of an ounce—of the precious substance. Their first report of the discovery of the new metal was based upon lines detected with the camera and spectroscope in the X-ray spectrum of platinum ores. A black powder of high melting point, rhenium is chemically active. Placed in a vessel of pure oxygen gas, it ignites spontaneously, leaving as ash a white oxide. It combines readily with other chemicals.

Science Weighs a Mountain

SEEKING to discover the mysterious forces that hurl molten lava from the crater of Mauna Loa, in the Hawaiian Islands, scientists now propose to weigh the entire mountain!

It is impossible, of course, to devise scales to weigh a mountain peak which reaches down some three miles under the sea. Instead, the scientists will use swinging pendulums suspended from carefully leveled supports to determine the intensity of the earth's gravity from place to place on the mountain. From variations in this intensity, they expect to discover whether the inner core of the volcano is lighter, so that it rises in seeking an escape, or whether other forces are responsible for the eruptions.

Rents and landlords no longer worry the thrifty Frenchman who built this bungalow boat

Railway Train Built from a Flivver

THIS odd locomotive starts with a crank. Once a flivver but now, with flanged wheels, a one-car train, it runs on the regular tracks of the Tabor and Northern Railroad between Malvern and Tabor, Iowa. Only rarely, when traffic is unusually heavy, is it replaced by a steam train. Even the signals on this line are out of the ordinary—an arrow shows which way the switch is turned.

How the Moon Affects Quakes

THE moon exerts a direct influence on earthquakes, points out Prof. H. F. Reid of Johns Hopkins University, as a result of recent investigations. Just as it pulls on the sea to form the tides, the moon strains on the earth. Should a "fault" or slipping of rock be about to occur for any reason, in a given direction, the moon in one position would hasten it; in another, it would delay it.

Device Takes Telephone Messages

SOON it may no longer be necessary to stay at home in order to receive telephone messages. A new Swedish invention answers the phone, takes the message, and repeats it to you when you return! The apparatus has been under test for several months and is now reported to have passed all tests.

When a call comes in to a telephone equipped with the device, the apparatus sounds two bells to indicate that no one is home, and a message must be left. Then it records the caller's voice, as he gives the message, on an unbreakable and inexpensive phonograph record, composed of a highly sensitive material coated on cardboard. Play the record when you return, and you know who called and what he wished to say.

Aluminum Made from Clay

COMMON clay now is to yield aluminum, in Germany, by a new process made commercially practicable by the phenomenal increase in the use of aluminum throughout the world. In the process the aluminum compounds are dissolved from the clay by means of powerful acids—a process made economically remunerative since the discovery that silica, a by-product of the new process, is valuable in many industries as a catalyst in the form obtained when aluminum is isolated. Although this scheme has long been possible in the laboratory, it has never before attained a commercial scale.

Leviathan Gets a New Dress

THERE is more to a great ocean liner than generally meets the eye—witness this unusual photo of the *Leviathan*, taken recently at South Boston, Mass. Put in dry dock for a fresh coat of paint, the ocean monster lies with the whole of its enormous hulk exposed. Note the relative size of the pygmies at work with paint and brush below the water line.

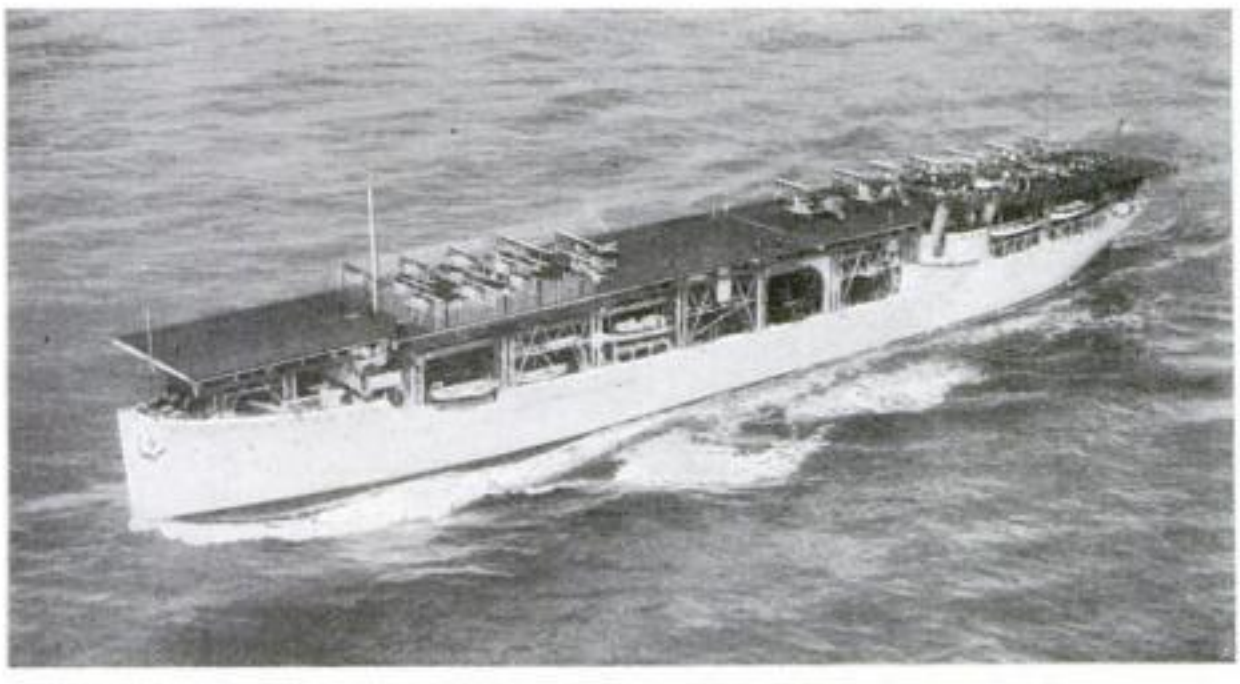
Wool Made from Pine Needles

CHEMICALLY treated pine needles are being made to yield a useful substitute for wool in Germany. In the process the resin is chemically removed from the needles, leaving a "pine wool" of fine strong fibers resembling hemp. This wool is woven into heavy fabrics.

The resin by-product is a valuable fuel. Shaped into briquettes, it has a high heat value and has been used in the manufacture of artificial illuminating gas.

An Air Fleet Goes to War

LIKE dragon flies on a floating piece of driftwood, twenty-five planes perched on the upper deck of the aircraft carrier *Langley*, pictured at the left, as it cruised along the California coast to take part in the fleet's recent battle maneuvers. The photo gives a striking picture of how a modern airplane carrier would look, sailing forth equipped for war. Note the corral-like inclosure on the landing deck above, and the unusual position of the ship's smokestacks, made necessary by the floating landing field. Additional planes are carried on the lower deck and in the hold.



The airplane carrier *Langley*, loaded with planes, speeding to the fleet's recent battle maneuvers

A 10,000-Watt Sun for Airplane Landings

GENERATING such terrific heat, when lighted, that a special glass had to be developed, huge 10,000-watt incandescent lamps are being made by the Westinghouse Company to light airplane landing fields at night. A single bulb, inclosed in a device similar to a lighthouse lens, is said to be sufficient to illuminate an airport runway 2,000 feet long. The new lights are intended to supplement the high-intensity searchlights now used on the fields.

In the illustration, an engineer of the company is explaining its features to Government officials.

Now—Ball-Bearing Trains

A STANDARD size Pullman car so frictionless that two men can pull it along the level rails, is the marvel made possible by new roller bearings for car wheels, replacing the present friction bearings. After a try-out on the Chicago, Milwaukee and St. Paul Railway, the bearings are being placed on more than a hundred cars—the first time that complete sets of passenger trains have been equipped with roller bearings.

In one test, a coach equipped with the regulation friction bearings commenced to move when the locomotive exerted 3600 pounds of force. Another coach, equipped with the new roller bearings, took only 500 pounds force to start it.

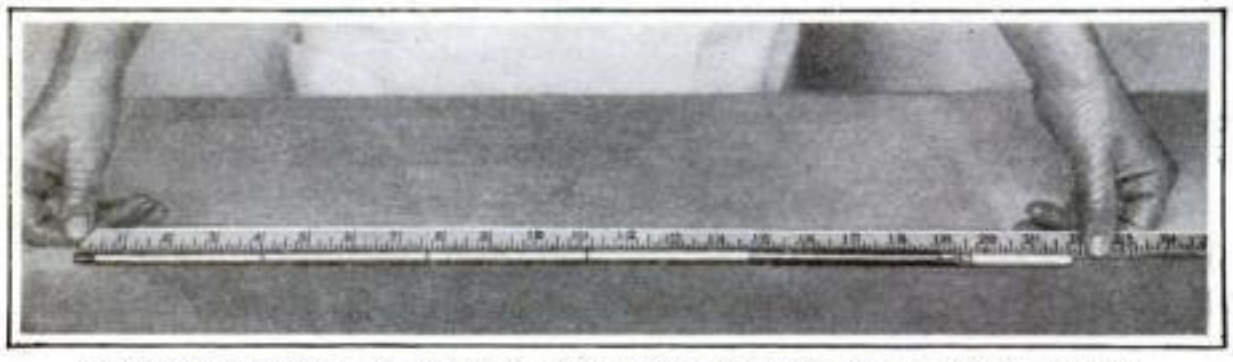
A 20-Inch Cigarette Holder

LONG-RANGE smoking is possible with the novelty cigarette holder below. Twenty inches long when extended, it telescopes to four inches to slip into a pocket. There's no danger of getting fumes in the eyes, either.

You'll Soon Be Phoning This Way!

TWENTY million telephone receivers and transmitters now in use in the United States are gradually to be replaced by a new type of telephone, pictured above, combining receiver and mouthpiece in one. Patterned after the European-type phone, the instrument is the product of experiments by the Bell Telephone Company, and is said to be an improvement on the Continental type.

It is easy to use—simply lift the phone off its rack, as shown above, and hold it in position at mouth and ear. Replacing it on the rack shuts it off. Its convenience is obvious, and, being only half as high as the present desk telephone, it cannot be knocked over so easily.



Insuring a cool smoke—extended, this holder measures twenty inches; it collapses to four.

Corner Subways for Pedestrians

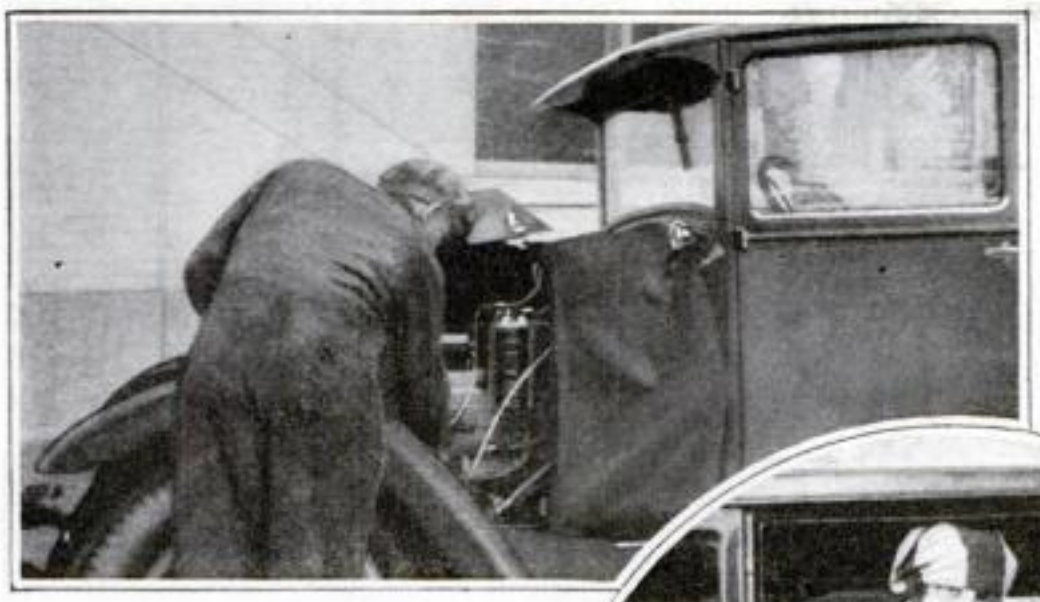
PICTURED above is the entrance to one of thirty-nine tunnels that the city of Los Angeles, Calif., has built at its most dangerous street crossings, to make it possible for persons on foot to cross the street in safety. Children on their way to school, in particular, are protected from the growing streams of motor vehicles that make the crossings perilous; and where these tunnels are built, the "stop crossings" usually provided for school children are eliminated. The tunnels are walled, floored and roofed with reinforced concrete, finished with cement, and are about four feet in width. Their street openings are partly inclosed by cement curbings, to keep out water.

Although pedestrians are not obliged to use the concrete safety tunnels, most of them do; and it is said that accidents have become almost unknown wherever they have been installed.

Airplane Engine Fits in Pocket

BABY brother of the giant motors that drive great planes, this remarkable motor—and it actually runs—would fit in a capacious overcoat pocket. A two-cycle engine, it develops a quarter to half a horsepower to drive a small-scale propeller that air-cools it. Bore and stroke are only one and one half inches.

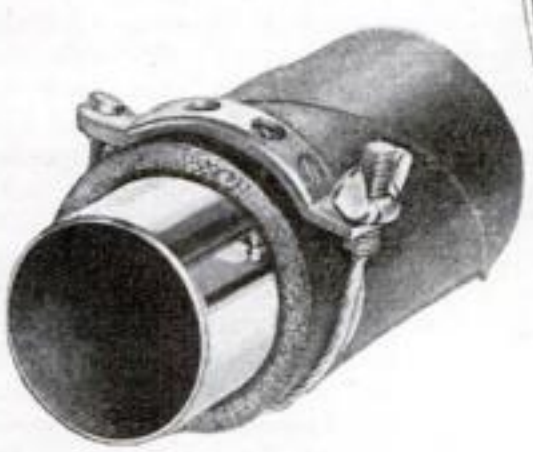
Handy New Aids *for* Autoists



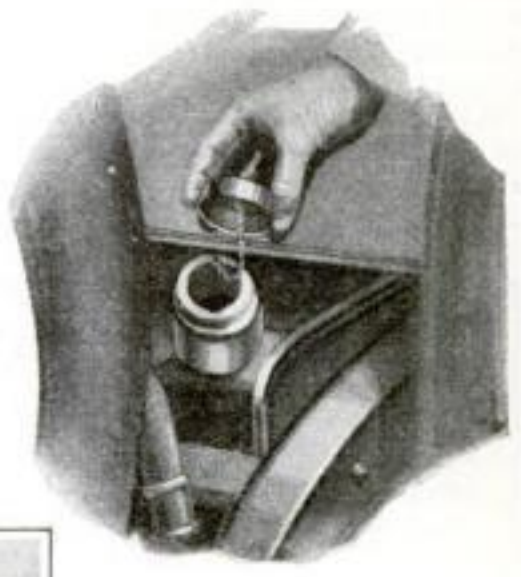
This new work-cover protects your mud guards and cowl when mechanics are working on the motor, and greasy hands, tools and metal parts can be rested where most convenient without marring the finish. Another section of the cover is placed over the driver's seat inside the car

L. G. Chapman, of Bangor, Maine, has invented an ingenious towline that is contained in a compact steel drum. The steel cable is kept taut by a spring, and automatically reeled in if the towed car coasts up to the rescue car, and this prevents the cable from wearing out by friction with the pavement or from becoming entangled with the wheels of the cars

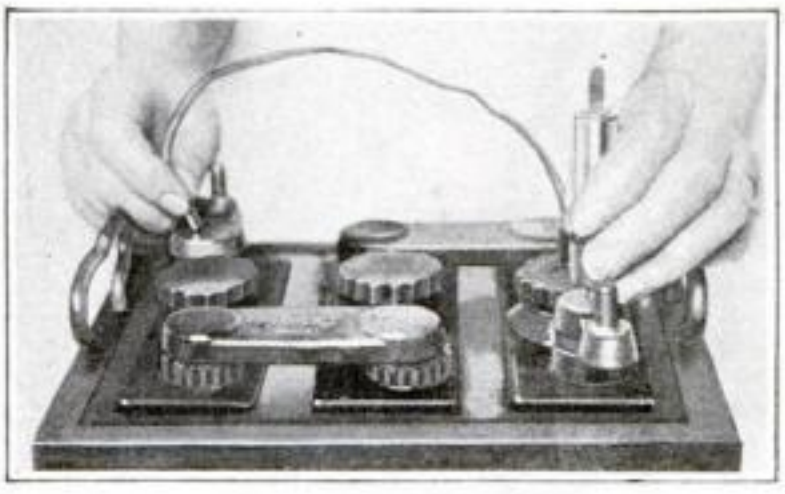
A novel sliding seat has just been placed on the market for use in autos fitted with coach-type bodies where it is necessary for rear-seat passengers to get past those riding in the front seat. The new seat is fitted so that, by simply pulling a knob, the whole seat slides forward out of the way



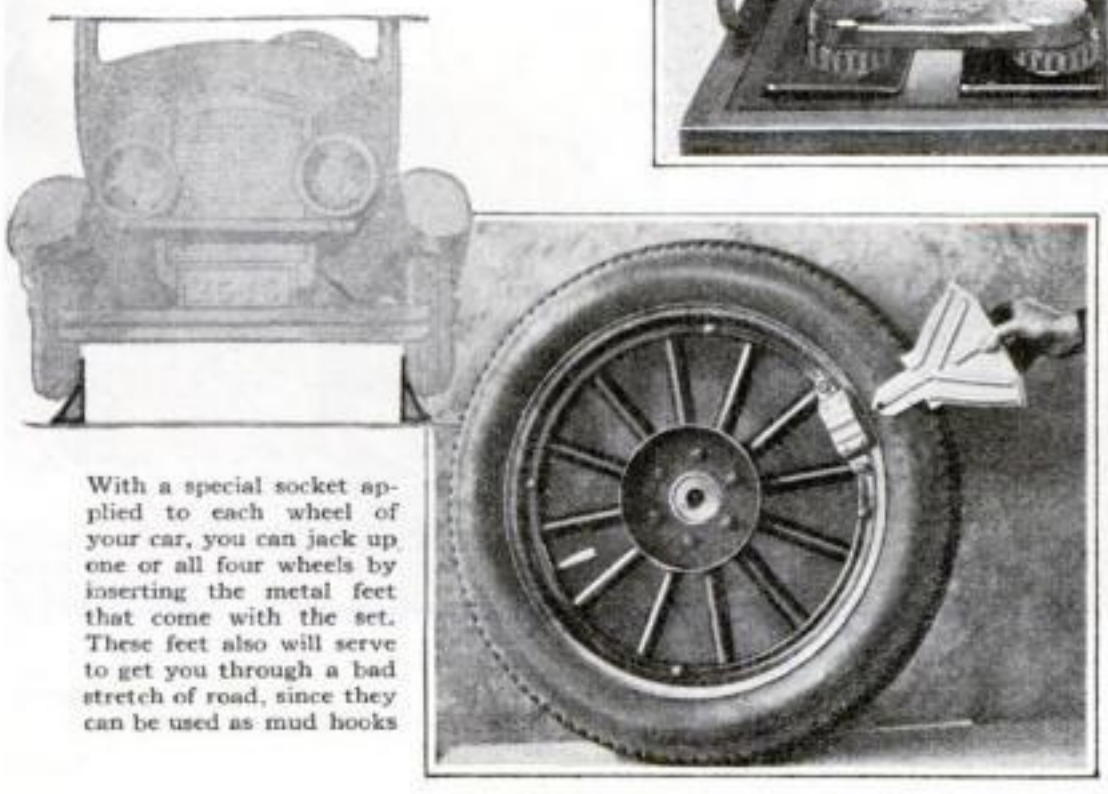
The unusual feature of this new hose clamp, invented by Paul H. Wilkinson, of Los Angeles, is that the clamping effect is obtained by means of a cable that passes one and a half times around the hose



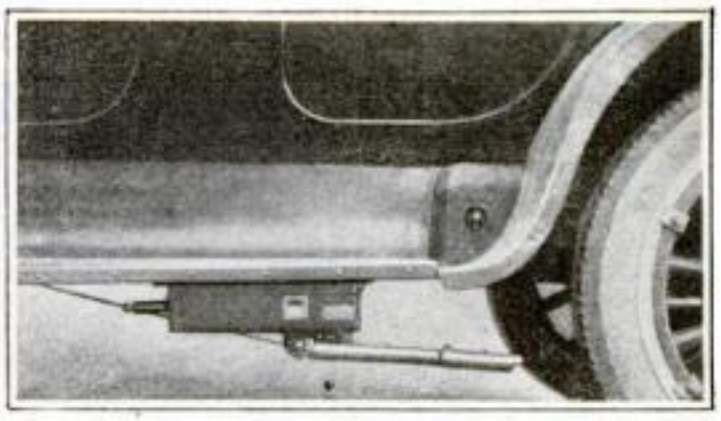
This new gas tank cap can't be lost because it is chained on, and it saves time because it is fitted with the bayonet type of lock so that only an eighth turn is required to attach or detach. A special adapter that fits over your present tank opening is used to receive the chained cap



A fair indication of the state of charge of the auto storage battery can be obtained by using a device of the type shown at the right. The gage, which fits the pocket, places a temporary load on the battery and tells the voltage

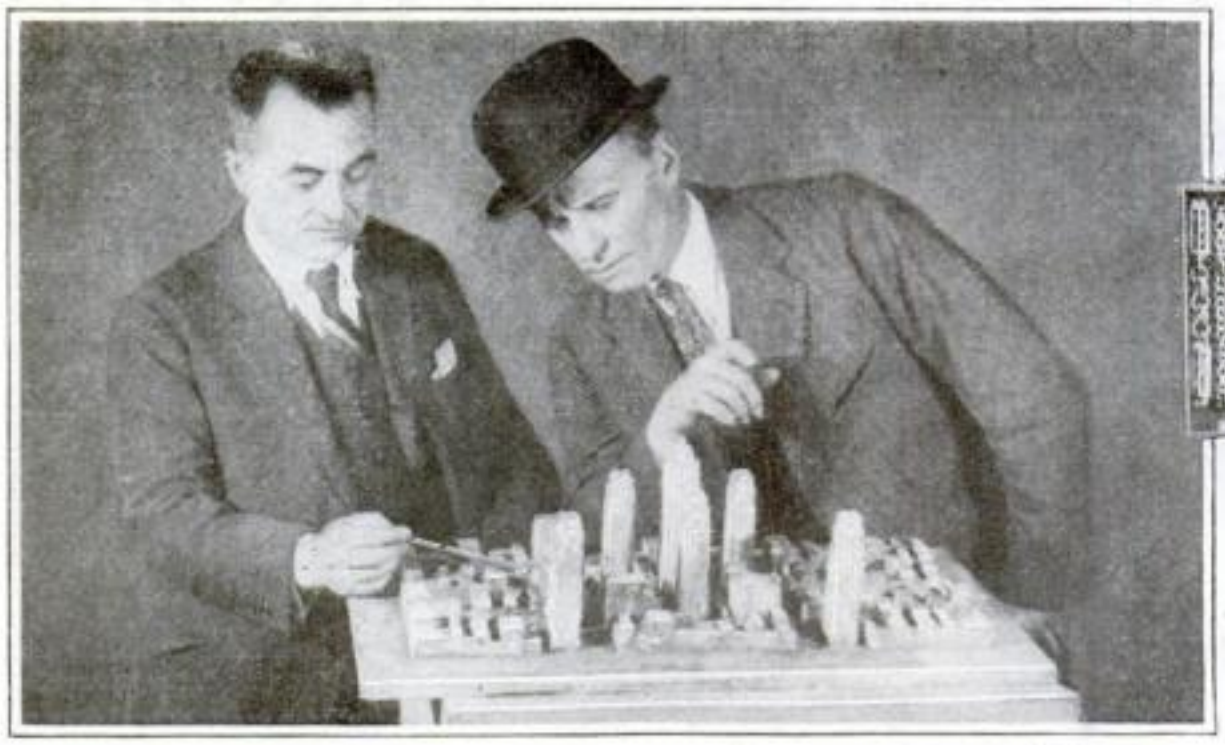


With a special socket applied to each wheel of your car, you can jack up one or all four wheels by inserting the metal feet that come with the set. These feet also will serve to get you through a bad stretch of road, since they can be used as mud hooks



A sand box to prevent skidding is the idea of J. W. Adkins of Oregon. Attached to the underneath side of the running board just in front of the rear wheel, pressure on a small lever on the steering wheel post throws a small stream of sand directly in the path of the rear wheel

Thinner Buildings, Wider Streets, for Future City



FUTURE urban buildings must be taller and thinner and occupy, relatively, less space as compared with streets, in the opinion of a New York architect, Raymond Hood. He would solve traffic problems of great cities by allowing six times as much space on the ground to streets as to buildings. Recently exhibited in New York, a model he has made to illustrate his plan shows how a city of low roofs might evolve, by careful planning and easy stages, into a city of isolated towers. In the illustration, Mr. Hood (left) is explaining the details of his novel idea to a fellow architect.

KNOW YOUR CAR

SAFETY in driving an auto at night depends largely on your headlights, when you get away from the brilliantly illuminated city streets. If your headlights should go out at a critical moment, perhaps going around a sharp turn, almost anything in the way of a serious accident might happen.

Of course, since you have two headlights, the chances are small that both bulbs will burn out at exactly the same instant. The chances are equally good that both lights will never go out at the same time through a breakage in the individual wires to the headlights. The most vital point, therefore, is that part of the wiring from the battery through the switch to the point where the headlight wires branch out. Observe these precautions, then, to insure safe night driving:

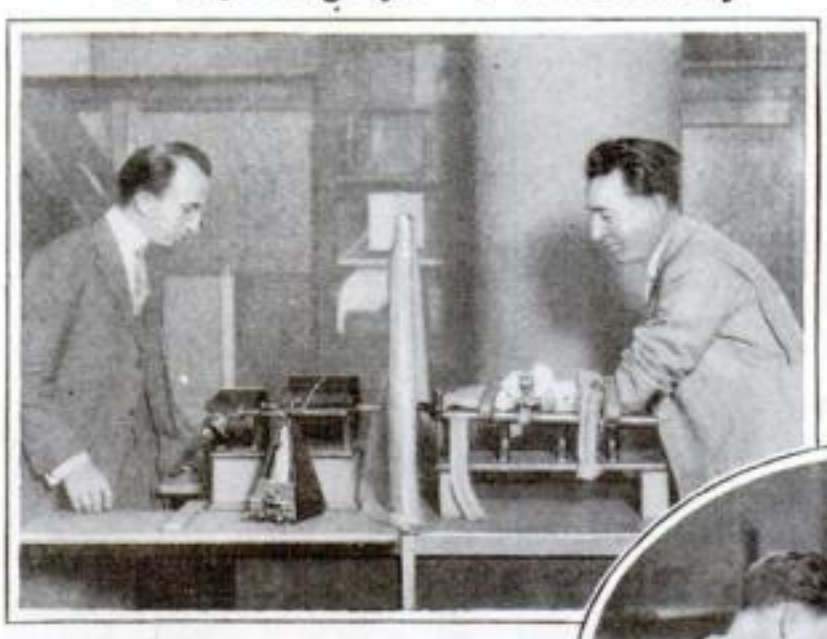
1. **Inspect the battery terminal connections at regular intervals.**
2. **Make sure that the wire connections to the lighting switch are tightly clamped.**
3. **Look over the wires occasionally to see that they are not becoming chafed or worn through at any point.**

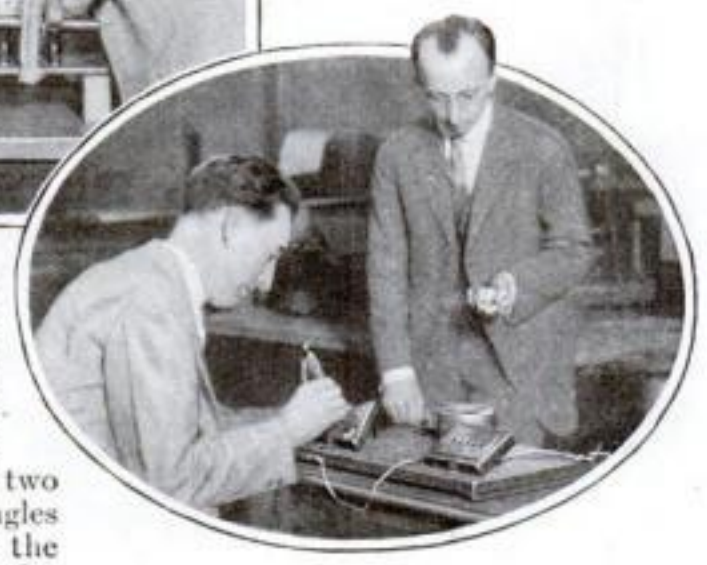
Sunspots Cause of Wars?

PERHAPS astrologers of old were not completely wrong in their belief that the course of human life depended on the stars. Prof. A. L. Tchijevsky of the Moscow Astronomical Observatory recently predicted "great human activity of the highest importance which may change the political chart of the world," as a result of the expected three-year period of intense sun spot activity that commenced this year.

Intense sun spots tend to excite human nervous systems, says the professor, and arouse masses of people to extraordinary activity. Most great wars and political crises, according to him, have occurred during periods of maximum sun spots.

A Noted Golfer "Tests Himself"





WILLIE MACFARLANE, former U. S. open golf champion, ran up against a brand-new set of hazards when he recently tried out the psychological tests at Columbia University. One series of tests ranged from estimating the length of two bars to picking out circles and triangles from a printed jumble. In these the former champion made high scores for delicacy of touch and accurate judgment of distance. On the intellectual tests, his marks bettered those of college students. The tests were conducted by Dr. A. M. Johanson, psychological expert.

Two of Macfarlane's tests. Above, trying to plunge a pointer in rapid succession through three holes without touching the sides. Each "miss" makes an electric contact. Dr. Johanson holds the stop watch. Upper illustration, measuring fatigue of fingers from pulling on a weighted cord in time with a metronome

Wisconsin's Champ Whittler

OUT of a single piece of wood, Fred Heiser, of Platteville, Wis., carved each of the intricate pieces spread on the table before him. Chains, pulley blocks and linked figures are among them, all of them designed by himself.

Canadian Police Signal System

WHEN Montreal's chief of police wishes to speak to a policeman or detective anywhere in the city, all he has to do is give a word to his desk operator. A moment later flashing lights on top of all the poles of the policeman's beat summon him to a phone, or give him orders through a unique numbered code.

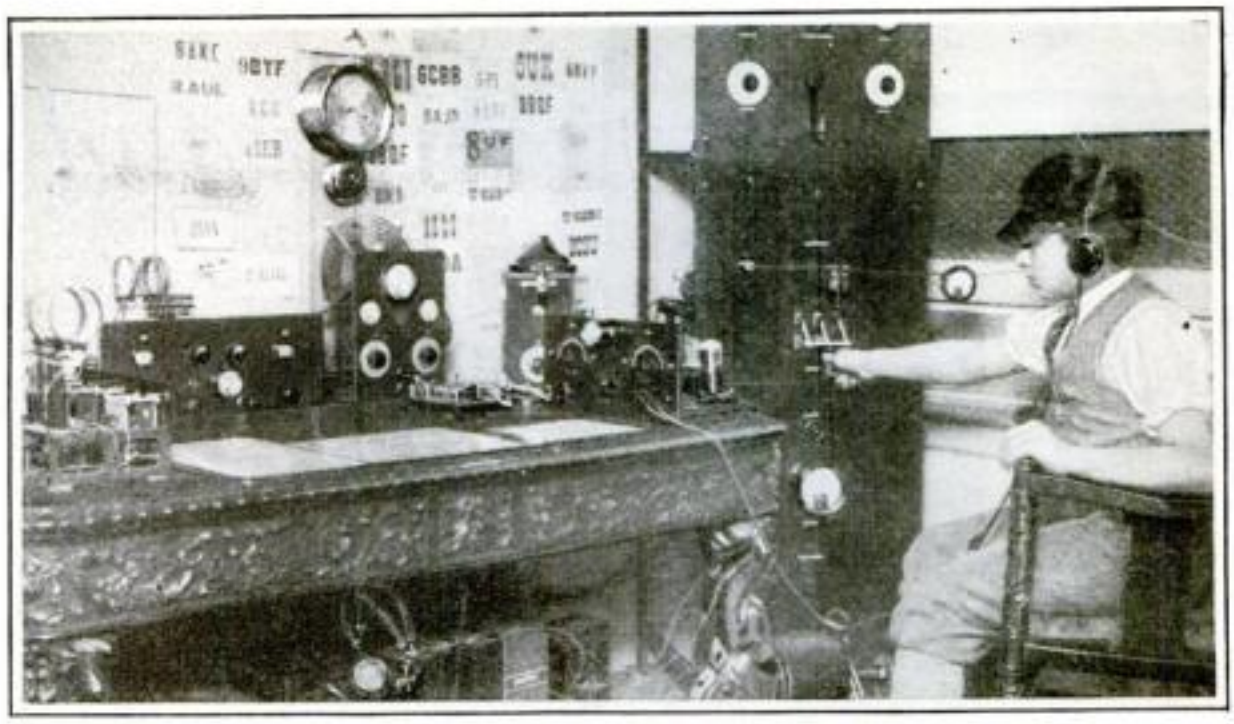
This is only one of the remarkable features of a police signal system the city has just installed. The moment an officer places his key in a police box, a bell starts ringing at headquarters. He need not even open the box in order to call the patrol. The operator can summon him back after a routine call by a buzzer audible 200 feet away. All calls are automatically recorded on a paper tape that shows, by perforations, why they were made.

In an emergency, the chief can transmit without loss of time a message to the city's entire force of police, calling them all to the boxes on their beat by the flashing lights.

Pygmy Hunter Back with Trophies

BACK from the wilds of Dutch New Guinea, Prof. Matthew W. Sterling, of Berkeley, Calif., leader of the Smithsonian Pygmy expedition, recently returned to report the discovery of a new race of pygmies. Strange ornaments and implements of the tribe, a few of which are shown above, were brought back.

THIRD NEW COMET to be discovered this year, an unrecorded heavenly visitor was sighted recently by Prof. Carl Leo Stearns of Wesleyan University, through the twenty-inch refractor at the Van Vleck Observatory, Middletown, Conn. Of only the tenth magnitude, the comet was invisible without a small telescope's aid.



12 Years Old, Runs Radio Station

YOUNGEST licensed radio broadcaster in the United States, Robert Marx, of New York City, converses with Europe every evening from his station 2AZK. Only twelve years old, he reads code signals at amazing speed. His wave length is forty meters, and his call letter is familiar all over the world. The illustration shows him at the main switch of his one-kilowatt transmitter. On the wall are call letters of stations he talks with.

Heartbeat Like Cannon's Boom

TWO hundred medical students at the University of Pennsylvania had the startling experience the other day of hearing patients' heartbeats, at a distance of ten feet, come to them like the booming of distant cannon. The sound was made audible by a wonderful new electric stethoscope capable of magnifying heart noises 500,000,000,000 times! If the energy of a pocket flashlight could be magnified to the same extent, it would develop more horsepower than all the electric generating plants in the world.

This instrument, a product of the Bell Telephone Laboratories, combines a stethoscope with an amplifier and powerful loudspeakers, revealing in startling fashion irregularities in heart action. Thus, when applied to the heart of one patient, the noise resembled the rumbling of a freight train over switches. In another case it was as if a man were beating a barrel with a hammer, halting for a rest at irregular intervals.

Violin Maker's Jackknife Art

WITH no other tool than a knife, Moise Potvin, expert violin maker, carved out of wood this remarkable detailed picture of a scene in his workshop. Like the familiar Swiss wood pictures, carved and framed in much the same fashion, the charm of this work lies largely in its faithful reproduction of such homely detail as an umbrella, coat and hat, and pictures on the wall. A near-by building can be seen through the window.

New Steel Defies Nicks

A NEW steel, said to be eight times harder than any of American manufacture, has been developed by the Fried Krupp works of Essen, Germany. Demonstrated recently in this country, it wore smooth the edges of steel files used in unsuccessful attempts to nick it. A cutting tool made of the new alloy severed cleanly the neck of a glass bottle.

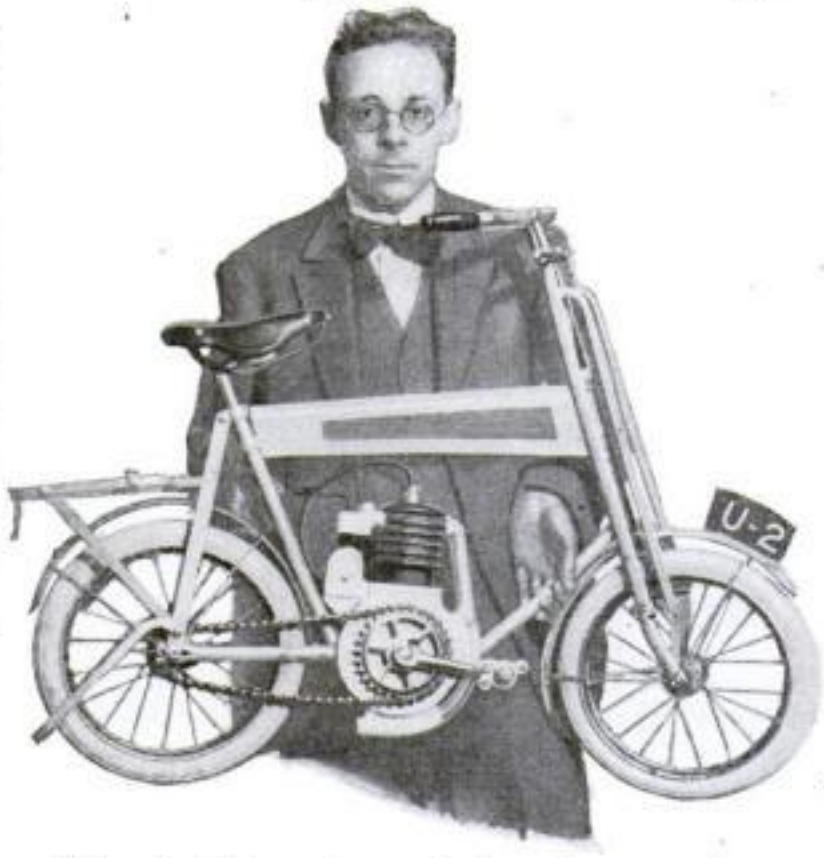
How Much Do You Know of the World You Live In?

TEST yourself with the twelve questions below, selected from hundreds sent in by our readers. For the correct answers, turn to page 144.

1. What famous harbor occupies the crater of an extinct volcano?
2. What famous trees live only on one small peninsula?
3. Who were the mound-builders?
4. Why do houses in Bermuda have whitewashed roofs?
5. Why are Panama hats made only in one part of the world?
6. Where are Roman skin-covered boats still in use?
7. What are the floating islands of the Nile?
8. How were the hanging gardens of Babylon supported?
9. Where are monkey ashes used for medicine?
10. Where does most tin come from?
11. Who began irrigation?
12. What is the difference between the White Nile and the Blue Nile?

Utility *and* Ingenuity

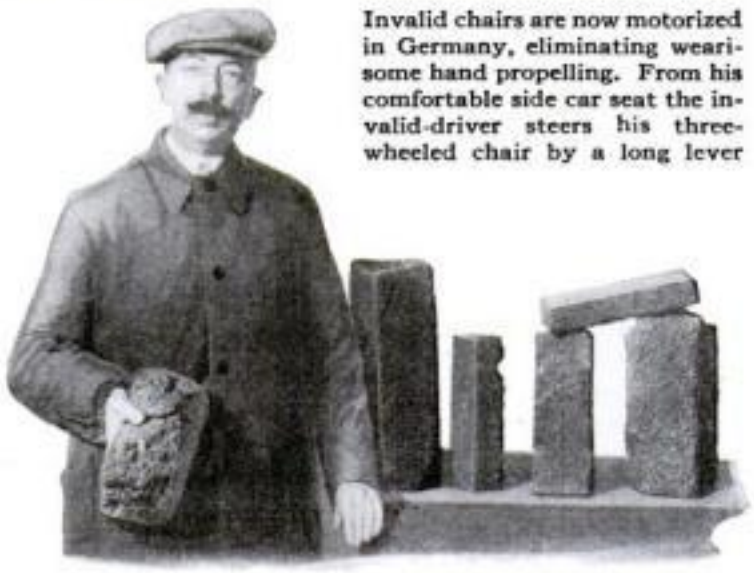
Molded concrete rings make smokestacks, cisterns and similar circular structures, in a new system of concrete construction invented by Hans Sorensen, of Beeville, Tex. Placed one atop another, the 400-pound rings built cistern at upper left



With make-believe motor, spark plug, carburetor and gas tank, this toy cycle for children is propelled by foot pedals

Waterproof suits, distinctly chic in appearance, are the latest adaptation of the new rubberized fabrics. Intended for summer wear, to anticipate sudden showers that would ruin another suit, they are made of lightweight treated fabric, said to be comfortable to wear and impervious to water besides

In this newest indoor golf game, an eighteen-hole "links" is laid out on a table somewhat like a billiard table. Billiard cues replace golf sticks, and the "ball" is a heavy disk the size of a silver dollar. While he makes an effort to sink the disk into the cup-shaped "holes," the indoor golfer encounters many a "hazard"—obstacles that bar approach to the holes



Invalid chairs are now motorized in Germany, eliminating wearisome hand propelling. From his comfortable side car seat the invalid-driver steers his three-wheeled chair by a long lever

Taking such waste materials as ashes, shavings and peat, Johann Ludwig, of Vienna, compresses them into bricks reported to be of high heating value as fuel

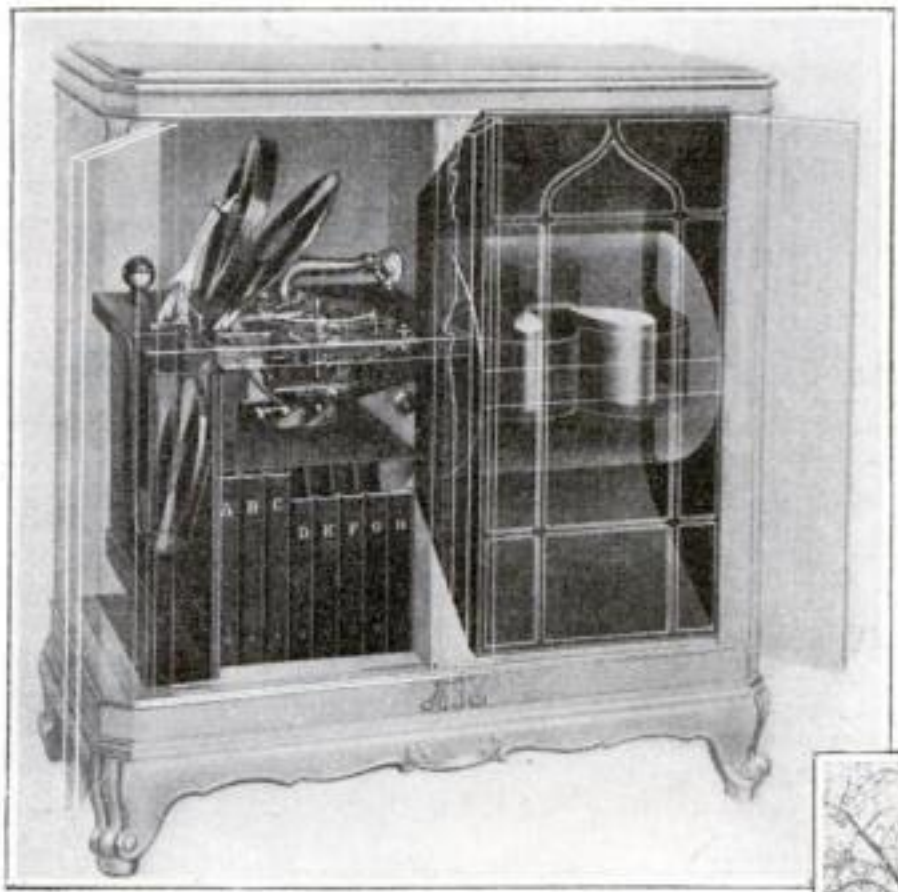
in New Inventions

Hundreds of copies of a criminal's finger prints are turned out rapidly by this duplicating machine, invented by Lieut. William Burns, of Baltimore. The new device works like a mimeograph machine

A tenth of a thousandth of a millionth of an ampere—that is the current that this amazingly sensitive new electric measuring instrument can record. The device is used in tests on electric lamps

(Upper picture). Close-up view of the new electric measuring instrument, known as a "thermionic microammeter"

Invented to aid a lame night switchman on a Boston railway, this combination lantern-cane supports the lantern, can be waved to signal a train, and can be spiked into the ground if desired



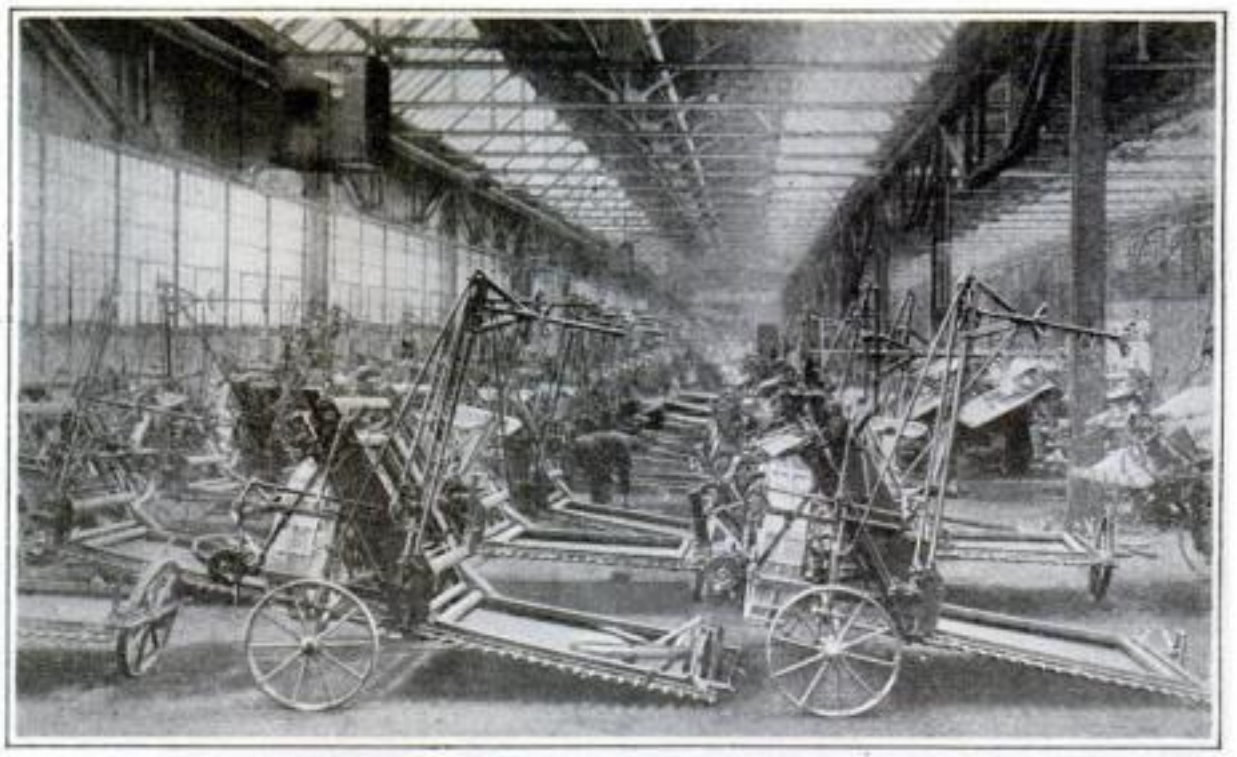
A phonograph that plays for a full hour without attention! This latest development in talking machines is made possible by a device that automatically feeds twelve records to the turntable from a magazine, with half-minute stops between

Monkey wrenches in the hands of three men put this "permanent but portable" house together in eight hours. Walls of insulating fiber are screwed to a frame of steel rods, the exterior is stuccoed and interior coated with a special composition

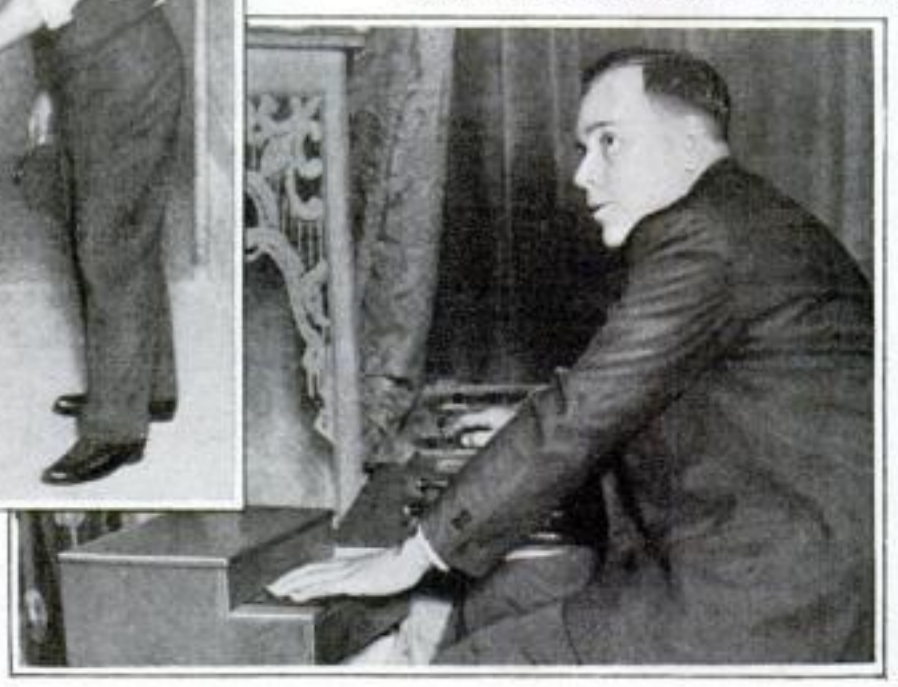
Cigarettes and matches go together in this ingenious new combination case. In the bottom of the leatherette pouch is a holder for safety matches. The top holds a package of cigarettes

Krupp Works Turn to Peace

VAST workshops that once forged guns and shells to destroy human life have now turned to peacetime products, at the giant Krupp works, in Essen, Germany. The illustration at the right shows a corner of this famous war factory as it is today, with agricultural implements lined up awaiting shipment. These, with motor trucks, now are the main product of the plant, offering an example of the ease with which a modern factory can convert its machines to other uses.



Scene in the Krupp works—farm tractors and motor trucks are now its chief product



The color pianist at his instrument and (left) the electric equipment, including 6,000 lamps, with which he produces his effects

Color Piano Has 6,000 Lamps

HARMONIES of color to accompany orchestral music are created by a remarkable "color piano" perfected by Leo Geasland, of Los Angeles, Calif. With one hand working the ten keys of his instrument's keyboard, he creates flashing changes of purple, red and orange from 6,000 concealed electric bulbs. His other hand throws switches that control the banks of lights.

Certain color combinations or "chords" are said to have a particularly emotional appeal, heightened by music. Future compositions in color for the light-flashing piano might be written in modified musical notation; Geasland, however, plays his instrument by ear, or rather "by eye."

New Giant Dirigibles

THE Zeppelin factory in Germany has started construction of the aluminum frame of a huge airship designed for weekly trans-Atlantic passenger service between Spain and South America. This giant liner will carry 100 passengers, crew, luggage and mails. Eight large compartments will be fitted with every modern luxury. It will be completed in September.

Meanwhile, Uncle Sam's project for two super-airships, each of 6,000,000 cubic feet capacity, has been clouded by worry as to how they can be inflated. America faces a shortage of noninflammable helium gas. There never was enough to float the *Shenandoah* and *Los Angeles* at the same time and each of the new dirigibles will require three times as much helium as the *Los Angeles* now uses.

Also, the chief source of helium supply in natural gas at Petrolia, Texas, is failing. To remedy the situation, a new supply will probably be developed from helium-bearing gas at Nacona, Texas.

Quartz Motor Run by Radio

RUN by radio, a novel electric motor described by Dr. Alexander Meissner, German radio engineer, has as its rotating part a small plate cut from a quartz crystal. Placed in a radio circuit, the crystal vibrates and sets up air currents that cause it to spin. Too weak to be of practical value, the motor is, however, being studied with interest by scientists. Quartz vibrations in a radio circuit, they point out, have another interesting application in keeping broadcasting stations exactly on a proper wave length.

Fight Shipworms with Paraffin

WOODEN wharves, ships and houses are now being protected against shipworms by a special paraffin treatment developed by Dr. Paul Bartsch, marine biologist of the U. S. National Museum. The process consists of impregnating the wood with paraffin and two kinds of poisons, one to destroy all attacking animal life, the other, parasitic plants. Blocks of wood treated with the new compound have so far been kept under water for two years without being attacked by shipworms.

The paraffin treatment is now being tested for its efficacy against land armies of ants and bacteria.

Navy Mapping Southern Seas

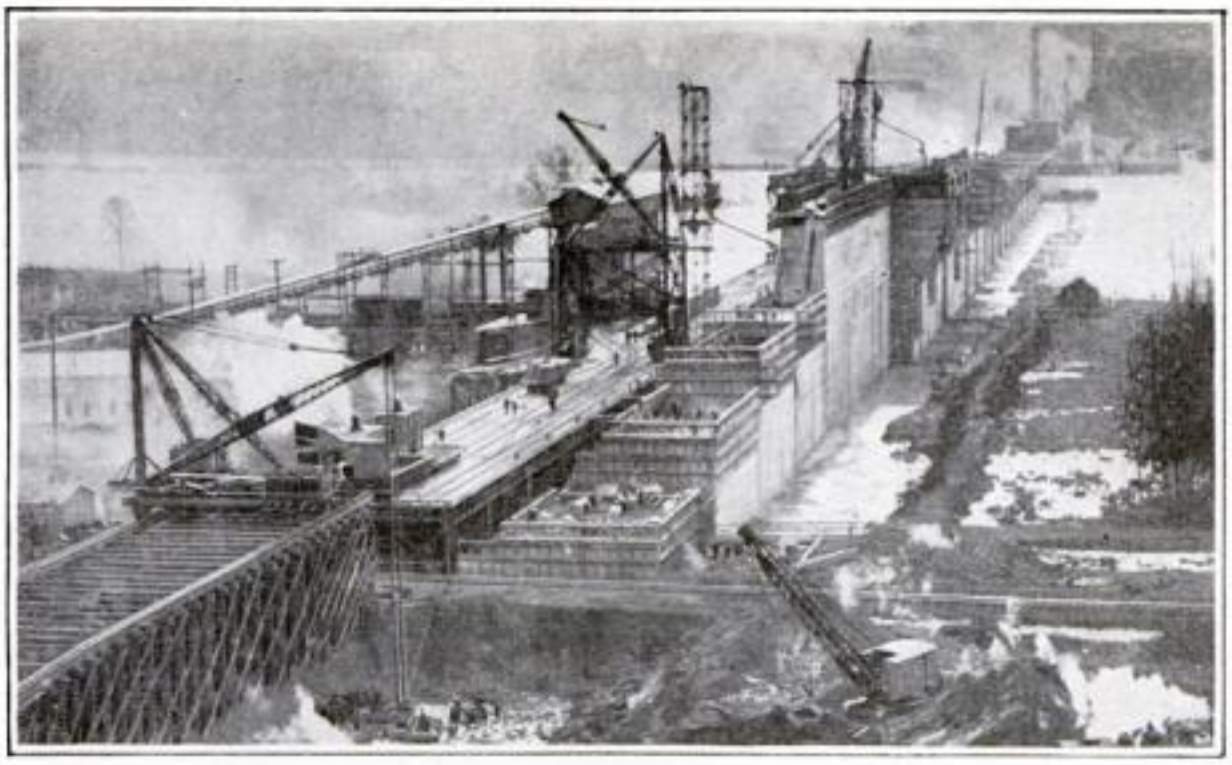
AERIAL cameras and sound depth finders are being used in a new survey of wide areas of seas off Central American and Cuban coasts, conducted by the Hydrographic Office of the U. S. Navy. Ships endangered by old and inaccurate charts of the ocean bottom—some dating back to the sixteenth century—will be provided with up-to-date, reliable data as a result of this expedition.

Three ships and two amphibian planes are making the survey. On shipboard an observer operates the "sonic depth finder" that projects a sound wave to the ocean bottom, while through his earphones the returning sound tells him how deep it had to go before it was echoed. Airplanes, meanwhile, photograph the coastline from above.

Bees Stupid, Scientist Finds

BEES haven't any common sense at all, says a French scientist, J. G. Millet. Instead of ,deserving credit for their industry and wisdom, he says, they don't even know a good honey-producing flower from a bad one. Experiments have convinced him that a bee is attracted to a flower solely by its odor—it will fly as quickly to a perfumed artificial flower as to a real one. Looking for sugar, it is satisfied that a sweet scent means a meal, and stupidly ignores odorless flowers with stores of honey.

PINK STAINS of mercurochrome, the new household antiseptic, can be removed from silk as follows: First apply benzaldehyde; then twenty-five percent hydrochloric acid; finally, sponge with alcohol, then with water. Mercurochrome spots should be removed before a garment is dry cleaned, as substances used in the cleaning will leave them indelible stains.



Part of Maryland's gigantic new hydro-electric plant on the Susquehanna, nearing completion

Maryland's Giant Power Plant

GREATER than Muscle Shoals and second only to Niagara's huge generators, this monster power project on the Susquehanna River in Maryland will soon be completed. Seven great water turbine generators will dispatch electricity over a 220,000-volt transmission line to Philadelphia, sixty miles away. Nearly a mile long, the huge Conowingo Dam across the river is seen at its north end in the illustration. It will develop 350,000 horsepower—more than the present power of Muscle Shoals and enough to light ten of New York's "White Ways."

Carried 50 Miles by Tornado

PICKED up and carried away by a tornado recently, a sheet of heavy iron roofing was found fifty miles away from the scene of the wreckage, according to the U. S. Weather Bureau. The tornado tore to pieces a schoolhouse at Laplata, Md., and was later traced on the ground for only fifteen miles. It is believed a whirling vortex in the upper air sustained the piece of iron roof on its long journey.

Hormone Makes Hearts Beat

ANNOUNCEMENT comes from Dr. Ludwig Haberlandt of the University of Innsbruck, Austria, of the discovery of a "heart hormone," a powerful chemical compound secreted within the living heart and spurring it to action. This compound is to be classed with the secretions of the ductless glands, such as the thyroid.

Dr. Haberlandt discovered that extracts from the heart of a frog would act on the stilled heart removed from another frog, causing it to contract again. Experiments with the hearts of dogs had like effects. The Austrian scientist believes that the new hormone may prove valuable in medicine as a stimulant to weak hearts.

Twins' Finger Prints Differ

FINGER-PRINT identification has again been vindicated. When Prof. William Crowther of University College, England, recently asserted that George and Edward Ellis, twin brothers, had finger prints exactly alike, police authorities the world over, alarmed, appealed for information. Scotland Yard, England's famous detective headquarters, made an investigation and found the twins' finger prints dissimilar. One had "three radial loops and seven ulnar loops," the other "one radial loop and nine ulnar loops."

Comet to Whiz Near on June 26

FOR the first time in a number of years a comet will be visible in the night sky a few weeks from now. The Pons-Winnecke comet, which visits us every six years, has again returned, and already astronomers are watching it through telescopes, measuring its brightness, and using the spectroscope to find what it is made of. The tail is known to consist largely of carbon monoxide, the same deadly gas that issues from an automobile's exhaust.

On June 26, the comet will be at its nearest—four million miles away, twenty-three times nearer than the sun. We may see it then without a telescope, in the southeastern sky about midnight.

More power to a steamer's propeller—two installations of the new "fins," which deflect water to the propeller

Baby Now Worth $9,333

THE fact that we live longer than did our grandfathers is bringing us billions of dollars in cash, says a great insurance company whose experts estimate that the total increase in earning power of American men and women in the present generation, or since 1901, is $3,500,000,000. This gain, they declare, has been due largely to the extension of life.

In 1901, a baby boy at birth was considered to have a potential value of $7,553. By 1924 this value increased to $9,333. This gain also, they conclude, is due to the expectation of longer life, with a consequent longer period of earning capacity.

How Cool Should a Theater Be?

UNDER the direction of the American Society of Heating and Ventilating Engineers, women students from the University of Pittsburgh are being weighed and observed in novel tests to find out how a cooling system for a theater should be designed. The girls are weighed on special balances that record a change in weight of one-thousandth of a pound. From these weight changes, temperature standards will be established.

Propeller Fins Speed Up Ships

CURIOUS fins attached to the hull of a vessel near its screw propeller are used in a new English invention to increase the boat's speed and lower fuel consumption. With the ordinary form of ship, water flows in an upward direction to the propeller. The new fin device relieves the propeller of the work of making this flow of water move horizontally.

Tests of the device are said to have shown fuel economy, greater speed, easier steering and absence of a stern wake.

Edison Raising Rubber

THOMAS A. EDISON, world-famous inventor, sees the great cotton plantations of the South transformed into producers of rubber. With Henry Ford, he has established an experimental rubber plantation at Fort Myers, Fla., where he is conducting remarkable tests with rubber that grows from a "vine" and with special machinery, including a new combination reaper-press.

Edison's rubber seed came from Madagascar, and the vine is a perennial which grows without replanting and can be harvested annually without further cultivation. Both plant and machinery are still in an experimental stage, though so far the vine has successfully resisted cold snaps, even hurricanes.

THE AVERAGE person has about sixteen square feet of skin surface on his body, according to the Imperial State Institute for Nutrition in Tokio, Japan.

Solving Everyday Problems

Golf balls are speedily cleaned by this mechanical washer, and hands aren't soiled in the process. To wash a ball, the plunger is moved up and down, while the ball is rotated between twin brushes in a patented slot in the washer

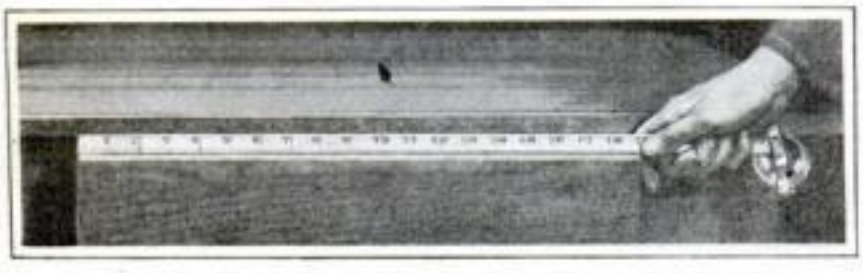
Intended primarily for military use, a new aerial camera needs no operator, but automatically takes pictures while the pilot maneuvers his plane. On each picture is recorded the time it was taken, the angle of the camera to the ground, and the altitude. Designed by Sherman M. Fairchild (left, above) the camera maps 180 square miles of territory without reloading

Strapped on a golfer's wrist, an ingenious device checks his swing before driving. At the top of its swing, the golf club has attained considerable momentum. To reverse it, the fingers are strained, often spoiling the shot. The leather swing check shown above is designed to eliminate this strain, preventing overswinging, slicing and hooking

When a typist taps out a letter on the standard typewriter keyboard of this unique electric machine, she finds it, when finished, completely set up in type that imitates ordinary typewriting. Placed in a press, it yields many thousand attractively "typewritten" copies of the original letter. Thus costly typesetting by hand is eliminated

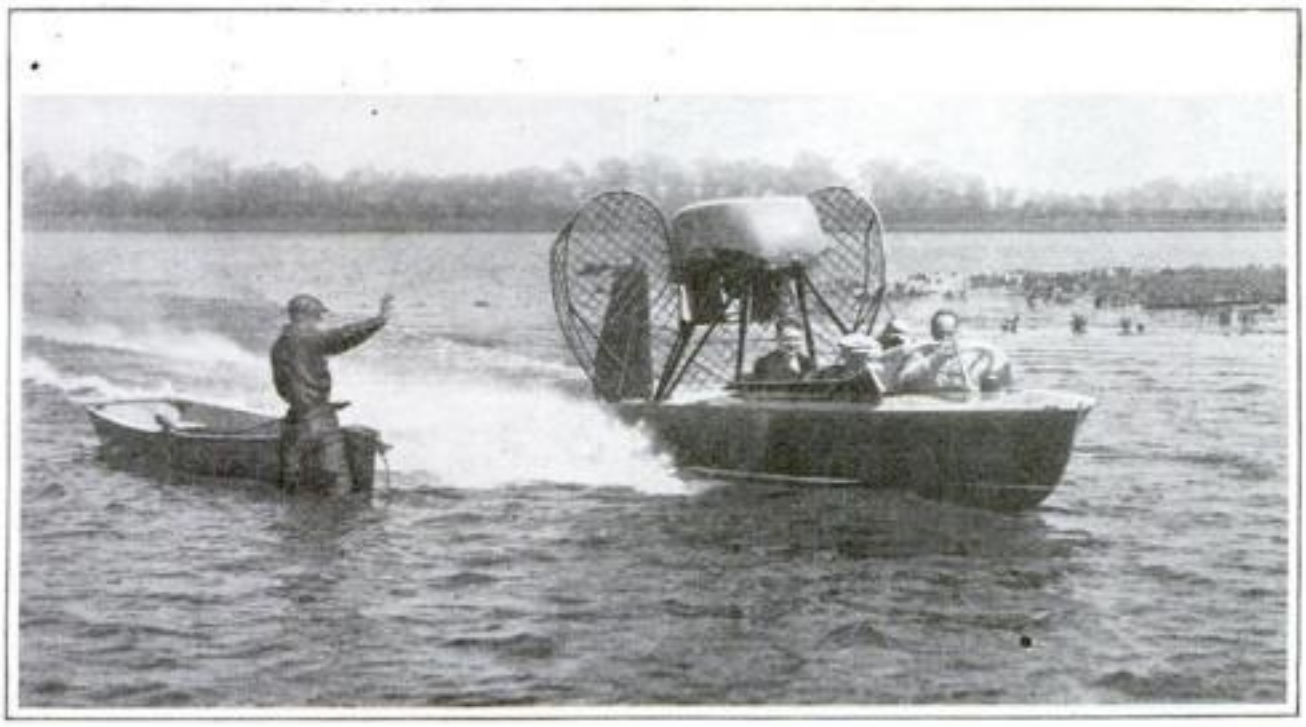
Slipped over the point of a pencil, this handy device is a letter opener and point protector combined in one. Its flat end for letter opening terminates the pencil point guard. It is kept from turning while in use by a slide ring that compresses the barrel to grip the pencil

Aid to the deaf comes in the shape of a new type of electric earphone that looks like a radio set. Twist its dials and hitherto inaudible sounds become strikingly clear. Not portable, it is for installation in homes or offices. The photo at the right shows Dr. C. W. Harper, of Boston, the inventor, demonstrating his new device



A six-foot measuring stick no bigger than a watch—that is the new metal rule that springs from a small coil to form a stiff, rodlike measuring stick. It is let out to any desired length, and pushes back into its case like a sword in its scabbard

Intercommunicating Phone, Home Bicycle Exerciser, Self-Operating Aerial Camera and Other New Inventions



Through shallow shoals where motor boats have never been before, or over ocean billows, this short draft boat skims at thirty miles an hour. Its aviation engine is placed behind the cockpit, above the deck, directly connected to the air propeller. The boat drives like an automobile, with all controls on the steering wheel, while the air and water rudder makes steering surprisingly easy

No more lost buttons—these new-style overalls haven't any! Instead, squares of reinforced cloth, sewn on for good, catch in loops to hold the garment neatly in place. At the waist, a detachable buckle clasps a belt strap, to insure a snug fit

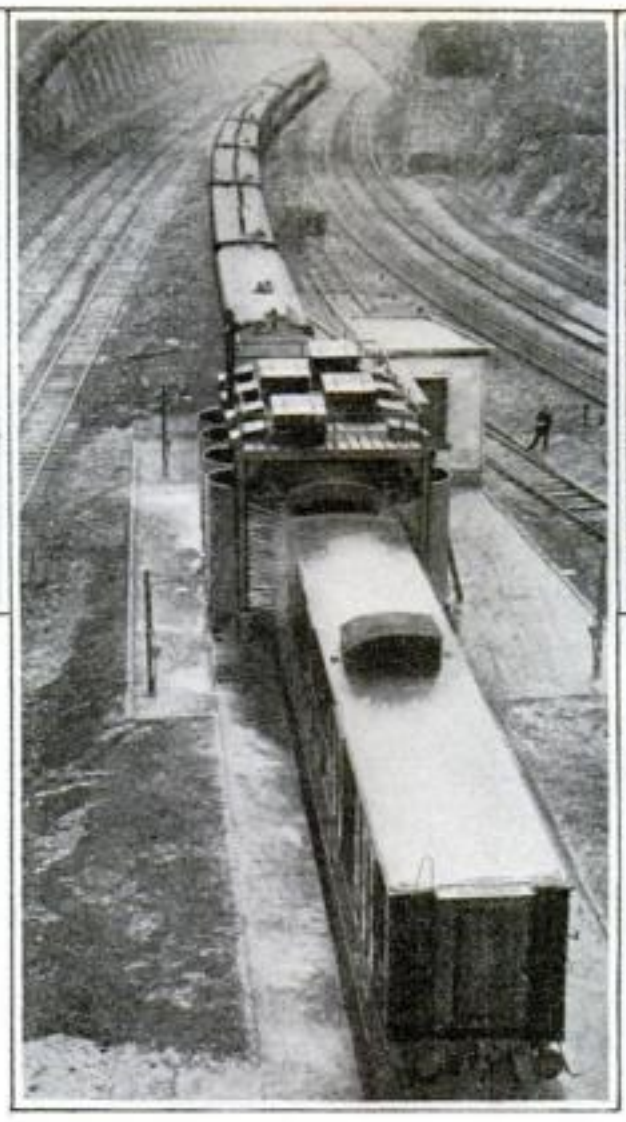
You can ride miles on this bicycle exerciser without going anywhere—and acquire muscle and vigor in the process. A speedometer counts the miles, and a friction attachment on the wheel calls forth any desired degree of effort to spin the pedals

With a microphone at your desk and a loudspeaker at your secretary's, you can give oral instructions at a distance without shouting. Or this novel intercommunicating system, substituted for the buzzer, can be installed at home between dining room and kitchen or house and garage. It runs on a six-volt dry battery

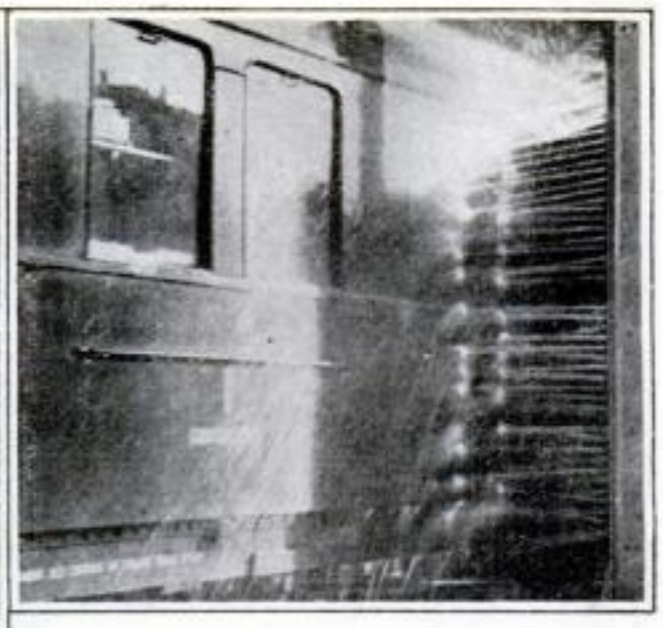
Two New York firemen invented this safety lamp, for attachment to the shield of the fireman's helmet when the fire fighter must work in smoky and dangerous places in a dark building. The lamp is lighted by ordinary flashlight batteries. Charles Becker and George A. Timlin are the inventors

Revolving around the sitter while a shaft of light throws his features in sharp relief from every angle, a new movie camera in a few seconds obtains a graphic motion picture record from which a sculptor can make a statue. Tedious sittings for the sculptor are largely eliminated, besides which the camera will be used to record permanently the features of persons of note throughout the world, for the use of future sculptors

Looking through the tunnel-like train washer, with its revolving brushes covered with rags



Washing a train in France. The coach passes through the machine in two minutes



A needle spray of water covers the entire side of the car, which emerges spick and span

Washing a Train "by Machine"

TRAINS on the Paris-Lyon-Mediterranean Railroad get their daily bath in what is perhaps the oddest washing machine yet developed—a huge tunnel-like structure that does the work of two hundred men. Known as a "train polisher," it is a tunnel about the length of a passenger coach, lined with revolving brushes and powerful jets of water. As the railroad cars pass slowly through the tunnel, they are scrubbed by the brushes and sprayed by the water, to emerge clean and glistening.

Each car remains only two or three minutes in the machine—a striking contrast to the time formerly taken by a small army of men armed with water pails, scrubbing brushes and rags.

Measures Huge Volcano's Heat

NEW scientific methods are being used to measure the heat of Kilauea, giant volcano of Hawaii. Under the direction of Dr. T. A. Jaggar, director of the Hawaii Volcano Observatory, borings ten feet deep dot the solid rock at the crater at intervals of a thousand feet. As soon as the temperatures within are taken and recorded, the holes are capped with metal rings to preserve them, so that they can be used for future observations.

Pioneers of aviation considered the catapult the only practical method of launching a plane. Langley hoped to launch his ill-fated "aerodrome" from a catapult; and the Wright brothers used one that was remarkably like those of today. Now, instead of "taxi-ing" to get a running start, planes again are jerked into the air by mechanical means.

Gasoline from Lignite Achieved

TWO French chemists, Prudhomme and Houdry, announce that they have made gasoline from lignite in commercial quantities. Their process of distillation, now a closely guarded secret, is eventually expected to yield a quarter of a billion gallons of gasoline a year—half the gasoline consumption of France—from twenty million tons of lignite. Coarser oil is a by-product.

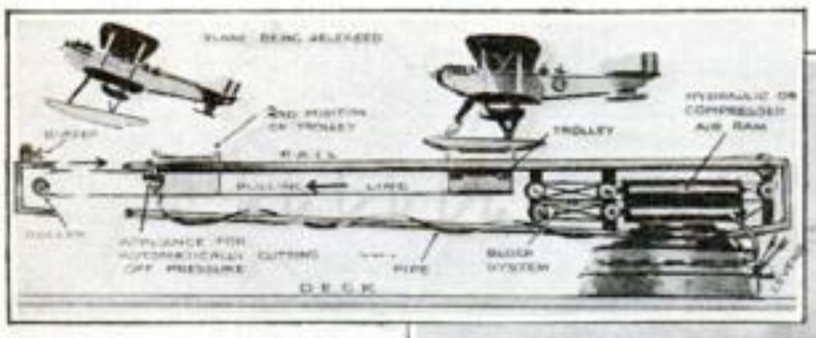
Enough lignite, sometimes called brown coal, exists in France, experts estimate, to supply that country with oil and fuel for at least a century and a half. Abundant deposits occur in the south and west of the United States, now unused.

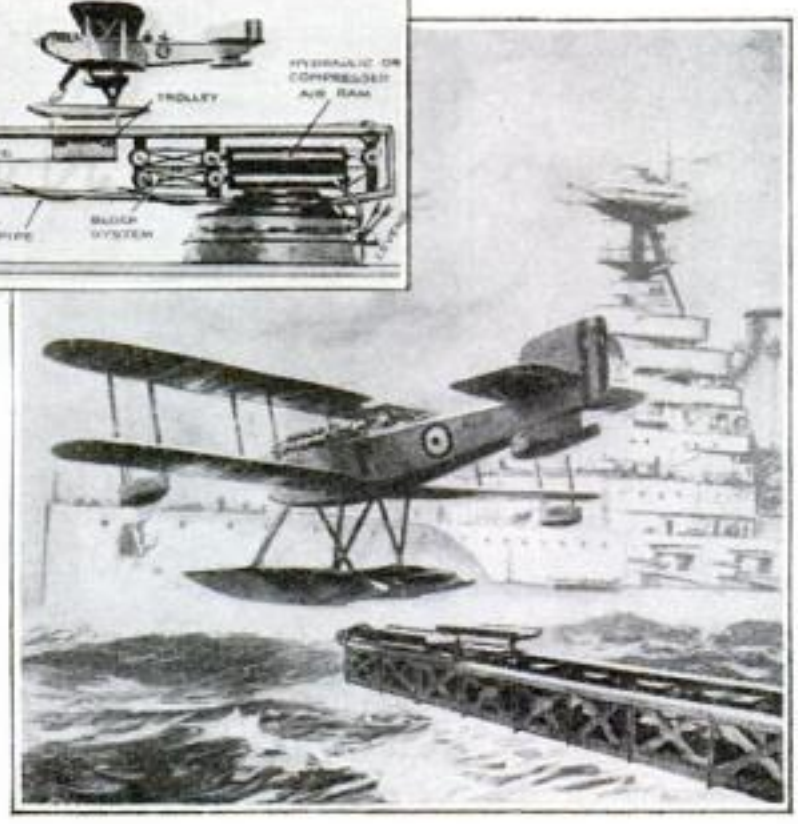
Epidemics Mild or Severe

SOMETIMES whole tribes of disease germs suddenly go on a rampage, like mad men running amuck, causing severe epidemics, according to Sir Humphrey Rolleston, British physician. He points out that diseases vary from year to year in character and intensity.

Though two such outbreaks—influenza and measles—occurred last year in the United States, reports just published show that 1926 set new low records in deaths from major diseases, a tribute to progress of medicine and sanitation.

Measles and whooping cough can be prevented or treated by inoculating exposed children with blood from the parents, according to Prof. Rudolf Degkwitz, European authority on measles. This practice already has been adopted in Germany. Repeated exposure to these diseases has stimulated resistance to them in the blood of adults, Prof. Degkwitz declares, making the parents' blood an effective agent of immunity.





Latest British Airplane Catapult

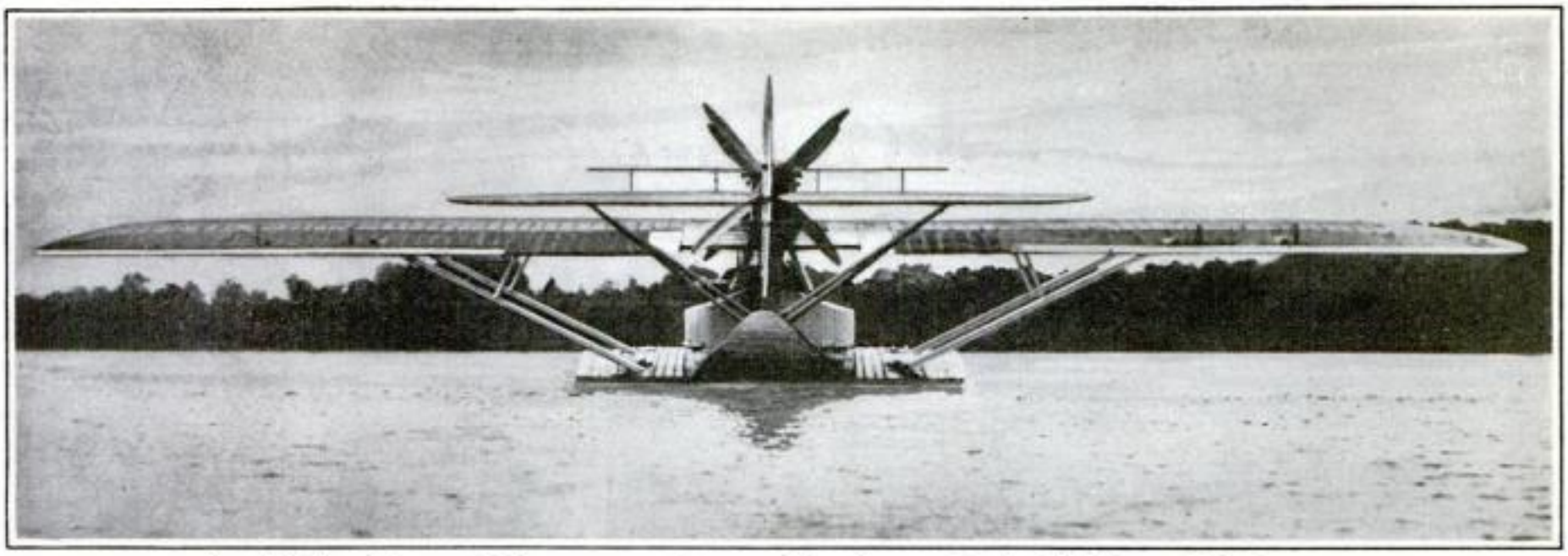
HOW a naval seaplane takes off from a modern warship's deck, catapulted from a revolving platform, is graphically shown in the accompanying sketches. This latest catapult, now in use on England's battleships, hurls a plane from a moving platform set in motion by compressed air cylinders.

Invisible Rays Solve Crime

CRIMINALS who alter documents with any ink that contains iron can be detected by ultra-violet rays, according to Professor Brüning, Berlin scientist. Postal thieves who open letters and reseal them also are branded guilty by the rays; one kind of mucilage, for instance, glows with a fluorescent light under them, while another does not.

Artificial pearls, however skilfully made, are revealed as false, as are imitation diamonds; the finest genuine diamonds shine with a magnificent purple light under rays of the ultra-violet lamp.

DECLARING that dark-clothed pedestrians walking along roads at night jeopardize their lives and make autoists involuntary man-killers, the author of a bill introduced in the Connecticut legislature would compel night marchers to carry lights.



A real air liner—Germany's 110-passenger seaplane, seen from the rear, after its trial flight over Lake Constance

Plane Carries 110 Passengers

CARRYING 110 passengers, this mammoth seaplane, just completed at Friedrichshafen, Germany, sped over Lake Constance on its trial flight at more than 120 miles an hour. A feature of its construction is the tandem four-bladed propellers, one in front of the single main plane and another just ahead of the rudders. It is shown above from the rear.

Future planes of this type may be constructed to carry huge loads of freight or serve as fleet ocean liners of the air.

Magnetized Area Fine for Radio

OWING to its large deposits of magnetized iron ore, Magnet Cove, about eleven miles from Hot Springs, Arkansas, brings in radio waves with exceptional results. Tests made with small machines set upon the large boulders of magnetized rock showed that stations were clearly heard at this point that would be received most feebly in other equally distant locations. Further tests are to be carried on.

Magnet Cove has credit for having the largest deposits of magnetized iron ore in the world. In this area a compass will not work. Surveyors cannot use the tools that are commonplace elsewhere. Small rocks of this area, naturally magnetized, have been sold to the laboratories of many colleges and schools.

Plant Redwoods in Virginia

GIANT redwood trees, California's forest monarchs, may appear in Virginia, if experiments prove successful. H. M. Sears, supervisor of the national forest at Natural Bridge, Va., is preparing a shipment of California redwood seedlings, to be planted near Natural Bridge. The trees are prized for their lumber, which has great durability.

Flier's Chief Requisite—Nerve

WHY can some men fly safely, others not? What qualities make a good airplane pilot?

The School of Aviation Medicine, San Antonio, Tex., has undertaken to answer these questions. To this end they are aided by a remarkable instrument which tells the speed with which a man reacts to signals in color, light, and sound, and the speed and coördination of his movements.

The chief requirement of a good flier, according to Capt. Neely C. Mashburn, chief psychologist of the school, is "nerve." To determine a prospective flier's nerve, his personal history is studied carefully. Major Francis H. Poole, chief of the school, recently expressed the belief that ninety percent of accidents are due to the pilot and not the plane.

Why Candy Explodes

SOMETIMES candy explodes, and now and then confectioners find whole shelves of chocolate creams that have burst open. The cause, according to scientists of the U. S. Bureau of Chemistry, is yeast in the sugar filling. Ordinary yeast, like that used for making bread, will not grow in sugar; but there is a special yeast that finds the sweet creamy mixture ideal. Its fermentation produces gas that bursts the candy.

Radio Set for Aviators

A DISABLED seaplane drifting at sea may broadcast an appeal for help with the newest airplane radio, pictured above, designed by the U. S. Navy for just such an emergency. Small and compact, it is operated by a hand generator, and so works even when the plane's motors are dead. A set of quartz crystals enables it to transmit a steady signal on one of several different wave lengths.

In the illustration, the set is seen at the left, the hand generator at the right.

African Bird Fades in Rain

BRIGHTLY colored when the sun shines, the feathers of an African bird recently studied by Dr. I. Krumbiegel, German biochemist, become a sad spectacle when wet by the rain. The brilliant dye of its red feathers fades to a pale pink, the leak being caused by the ammonia in rain water. Food the bird eats probably furnishes minute quantities of the natural dye's ingredients, says Dr. Krumbiegel. Known as turacine, the dye is a compound containing copper.

Paris Tries Portable Semaphores

PORTABLE traffic semaphores are helping solve the traffic congestion problem in Paris. At specified hours of the day they are moved to street intersections where congestion is heaviest—during the business rush hours, for example—then at night they are carried to the theater districts, and on Sundays and holidays to crowded intersections near the railway stations. The first of the new signals to be tried out is seen above at one of the busiest crossings.

Tools *that* Lighten Home Tasks

Those who cook their own breakfast will appreciate this compact electric hot-plate that prepares a meal in a jiffy. A detachable handle saves space and burned fingers

Pick it up and it lights—put it down and it goes out. This bowl, in reality an electric match, can't waste current, for it shuts itself off. Always ready, it lights a cigar or cigarette safely

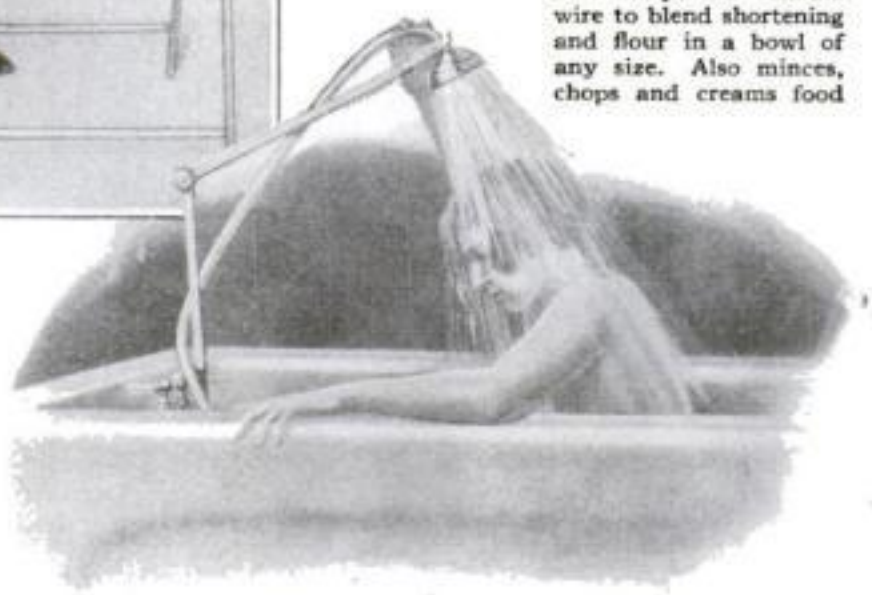
Round, square or oval cans are opened with this ingenious tool. Its two handles grip the can's rim with a roller and a cutting wheel. A few turns of a crank and the top of the can drops off clean-cut, leaving the bead on the can

(Right) This dish-washer brush makes short work of the dishes in the sink. Attached to the faucet by a rubber connection, it contains a soap chamber that adds suds to the hot water flowing in it. The brush is extra wide

A novel pie crust mixer uses loops of flexible wire to blend shortening and flour in a bowl of any size. Also minces, chops and creams food

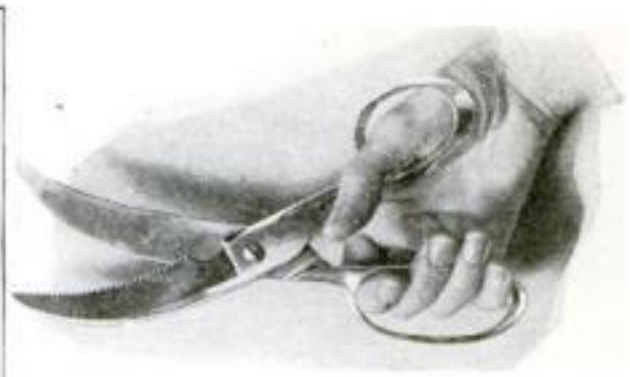
(Below) Press a button, and this versatile electric device mixes drinks or salad dressings, beats eggs or whips cream. With its adjustable stand it fits bowls of any size. Two sizes of beaters adapt it to a variety of uses

When there isn't much room to spare, this clothes rack shows its virtues. Adjustable in size, it occupies little space open, much less closed; and it can be taken apart for storing or packing. Light in weight, it is easily handled and moved about



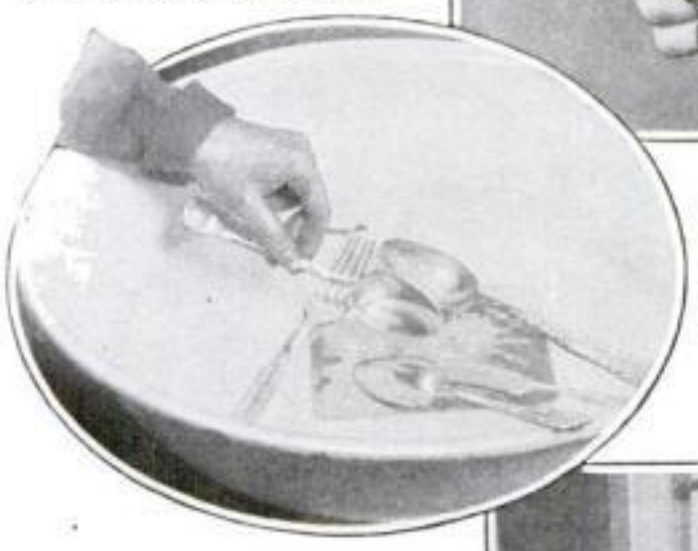
Any bathtub with a standard faucet can now have a shower by the simple attachment of this bracket device. A hinged metal arm, clamped to the faucet or to the wall, holds the spray nozzle at the desired height. Rubber hose connects nozzle and faucet

Two New Dish-Washing Devices, Can Opener, Faucet-Operated Cream Whipper and Other Novel Inventions



With one blade notched and the other straight, these new shears save the family scissors from nicks, cutting picture wire, clothesline, even fish bones, with equal ease

(Below) Silver magically loses its tarnish, placed in a dish and touching a new aluminum plate covered with hot sal soda solution. The magic used is an electrochemical reaction



Built for long life, this four-edged can opener uses one blade at a time. When one is dull the other is ready for service. Two bottle openers complete the double-life tool

Slide back the top of a new kitchen table and out comes an ironing board. Ordinarily hidden beneath the porcelain table top, the disappearing board swings into a convenient position for use

Milk bottles become pitchers with the attachment of this lid to its neck. Tilt the bottle, press the plunger, and a stream issues from the spout

One ten-pound cake of ice is made in an hour in this ice-making machine for the home. Tip it on its side in the cradle rack and out slides the ice. When no ice is needed, the electric current is shut off

(Left) A graceful new electric humidifier, when filled with water once daily and then plugged into the electric wall socket, keeps the air in a room moist and healthful

While hot water courses through a tube in this novel dish washer, its spinning electric brush is passed by hand over the dishes, removing and scraping all food. The device is hung by a sash cord from a weighted pulley to make it easy to move in any direction

Attached to the kitchen faucet, an ingenious mixing device lets water power do the work of beating eggs, whipping cream and so on. It fits any tap, and contains a small water turbine that whirls the blades that do the mixing

World's Oldest Book *at Last* Deciphered

Dr. Lutz, who has deciphered Hittite writings 4,000 years old

AIDED by a sharp chisel, Dr. H. Lutz, of the University of California, has just finished reading the oldest book known to man. The task has taken him twenty years. The chisel was necessary because the "book" is a series of clay tablets, about the size of a pocket notebook, each incased in a baked clay sheath, which had to be chipped away by the sharp tool. Dating from a period between 2,000 and 2,500 years before Christ, the book is part of the records of the little-known Hittite Empire, and explains hitherto baffling mysteries of ancient civilization.

Map of ancient Hatti Empire as reconstructed from new data

The tablets were dug up in the ruins of the Hittite capital, near Angora, Turkey, with other letters and documents, all inscribed on sunbaked clay and filed away just as a modern business firm keeps its records. The writing was done while the clay was soft. When a tablet was to be sent any distance, powder was sprinkled over the text and the tablet wrapped in a soft, wet, clay "envelope." The powder prevented sticking, and the recipient broke off the clay wrapper with a thin chisel.

The text, as Dr. Lutz found it under the clay envelopes, was in the cuneiform or dart-like characters of ancient writings.

Once natives of the country known as Hatti, now modern Turkey, the Hittites are disclosed by Dr. Lutz's translation as a sort of "missing link" between Babylonian and Greek culture. Such Biblical tales as that of Moses, Saul and David, as well as the legends of the Iliad and the Odyssey, the origins of which have long been a mystery, are revealed by the tablets to have come down to us from the Babylonians and Chaldeans through the Hittites.

Cuneiform writing on Hittite tablets, now deciphered. It is read vertically, top to bottom

Hittite rock carving, showing Babylonian influence. It represents a priest carrying offerings

Winners in Our March Stomachion Contest

Baseball Player Third Prize
Louise S. Lovett, Weaverville, Calif.

The Pitcher
Mrs. C. S. Dickinson, Minneapolis, Minn.

Tennis Player Second Prize
J. J. Leahy, Medford, Mass.

The Runner
Karl Steding, Wilkes-Barre, Pennsylvania

IN OUR March issue we offered $100 in cash prizes to readers submitting the best original designs on the subject of "sports" made from the fourteen pieces of the Stomachion puzzle game of Archimedes. A number of the prize winning entries are reproduced here. The prizes have been awarded as follows:

FIRST PRIZE, $25—Thomas D. Young, Frankfort, Ky.

SECOND PRIZE, $15—J. J. Leahy, Medford, Mass.

THIRD PRIZE, $10—Louise S. Lovett, Weaverville, Calif.

Five Prizes, $5 each

Horace F. Bell, Erie, Pa.
W. M. Mullins, Richmond, Va.
E. Schildknecht, Seattle, Wash.
J. G. Staehli, Des Moines, Iowa
Karl Steding, Wilkes-Barre, Pa.

Ten Prizes, $2.50 each

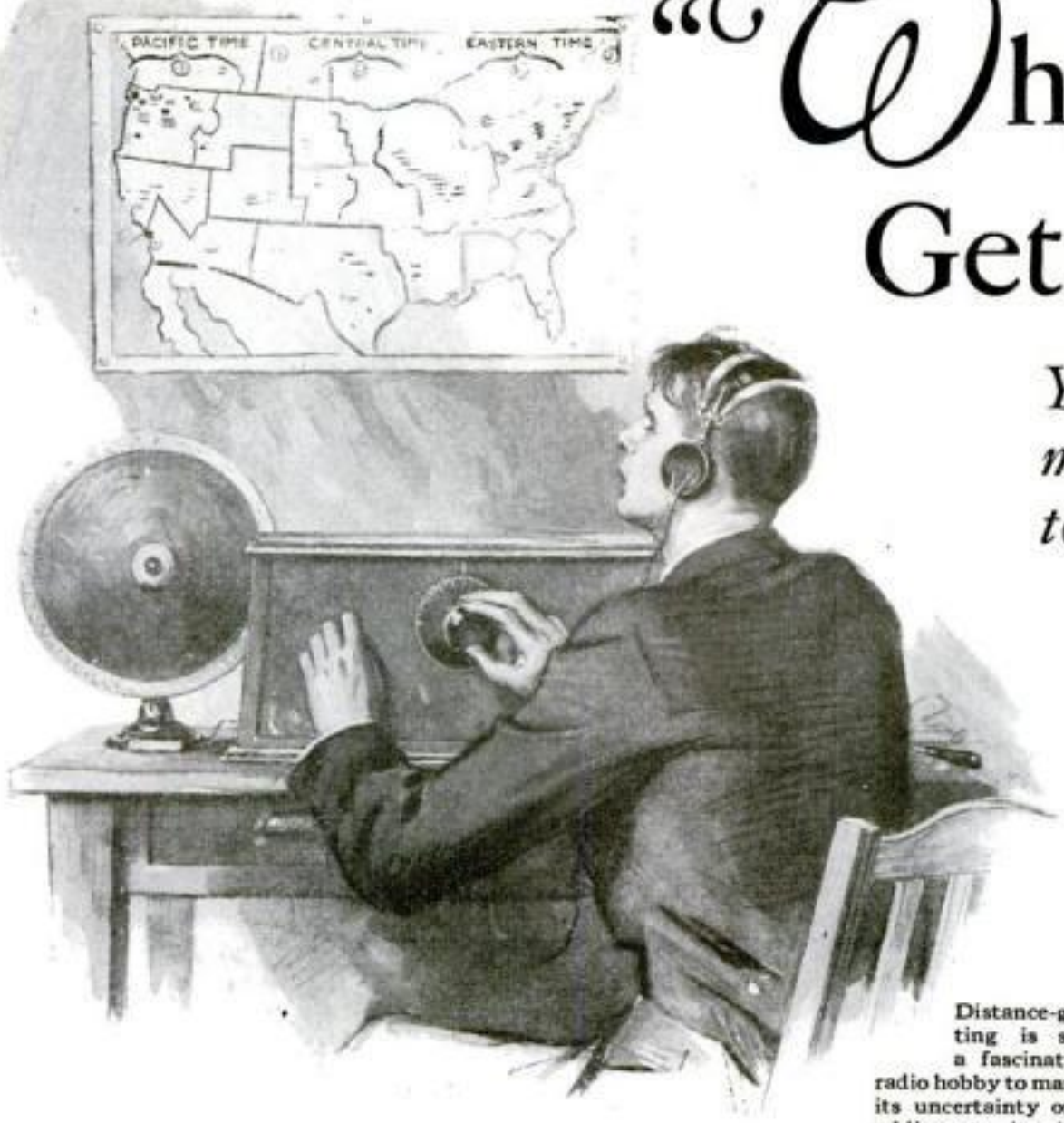
E. V. Bowers, New Ross, Ind.
Clarence W. Carroll, Rochester, N. Y.
C. L. Critchfield, New Brighton, Pa.
Robert E. Despard, LeRoy, Minn.
Mrs. C. S. Dickinson, Minneapolis
Hattie M. Little, Sebastopol, Calif.
Mrs. Ethel Reed, South Bend, Ind.
H. N. Toftoy, San Antonio, Texas
A. P. Wilson, Pembroke, Ont., Canada
Wm. J. Utz, Santa Cruz, Calif.

Steeplechaser First Prize
Thomas D. Young, Frankfort, Kentucky

"Why Can't I Get Distance?"

Your set or your location may be to blame—What to do for best results

By
JOHN CARR



Distance-getting is still a fascinating radio hobby to many, its uncertainty only adding to its lure

IT'S all very well for people who live in big cities to claim that radio fans no longer want to listen to distant stations, but the fact remains that a large percentage of radio listeners in this country must either bring in faraway stations in a satisfactory manner or else go without radio entertainment altogether.

If you are one of these, or still feel the fascination of listening to far-off stations, and have difficulty in getting worth while results, what's to be done about it?

First, determine the cause of your unsatisfactory results. Faulty radio equipment may be to blame, in which case the remedy is comparatively simple. If, on the other hand, poor distance reception is a characteristic of the locality where you live, you may be getting all that can be expected under your particular set of conditions.

Poor distance reception frequently is due to an inadequate antenna. Distance reception is always best on the highest and longest antenna you can put up. Of course, an extremely long antenna does not give the best selectivity, but if you must have distance the long antenna will help you get it. The mere fact that someone else is bringing in stations from Canada to Mexico on a thirty-foot antenna is no guarantee that you can do the same thing; the other fellow may be located where reception is particularly good. So the first step, if you are not satisfied with the number of stations you can bring in, is to see what can be done about improving your antenna.

Assuming that your batteries are all good and that there is nothing actually broken or disconnected about your receiver, the next step is to find out if the tubes you have in the radio-frequency and detector stages of your set are as good as they should be. Take them to your radio dealer and have them tested; if that is not possible, borrow a set of tubes from some neighbor long enough to determine if they improve results. The tubes in the audio stages of your set may be responsible for poor volume, but they have little to do with distance.

There is no way to predict in advance what kind of radio reception you are going to get if no receiver has been operated in your particular locality. That is why it is unfair to expect a radio set manufacturer to guarantee in advance that you will be able to get distant stations with any degree of certainty. All that any maker can do is to promise you that if it can be done, his set will do it.

OF COURSE there are sections of the country where reception is quite uniformly good over large areas. If you happen to live in such a section, your dealer can tell you in advance what stations are likely to be received best, but he can't be too definite even under these conditions. There always is a chance that some peculiarity of your particular locality may upset his predictions.

Experience has shown that it is possible to generalize on the possibilities of distance reception in certain sections. For instance, most of Westchester County in New York State is rather poor. Large areas in the middle west, notably in Ohio, Illinois and Indiana, are remarkably good. But even in good sections there are instances where distant stations are rarely heard, and in otherwise poor sections isolated cases crop up of particular spots that are extremely good. The radio fan who happens to be located in one of these spots usually is credited with being the possessor of a marvelous radio set because he has no difficulty in bringing in stations enormous distances away. Actually, his set may be not one whit more sensitive than that of another listener near him who has trouble in receiving a powerful station only a hundred miles or so from his antenna.

No one, not even in a favorable locality, can expect to get consistent reception from stations thousands of miles away during the daylight hours. It can't be done with any type of set made. In fact, operators of the most powerful broadcasting stations in the country declare that they can be absolutely sure of reaching listeners at any hour of the day or night only when they are not more than one hundred miles away.

While you always can expect greater range at night than in the daytime, some nights are much better than others. Frequently there will be several nights in a row when you seem to be able to get any number of distant stations. Then there may come a period of a week or two when the air seems totally dead.

These changes in the strength with which distant stations are brought in give rise to remarkable effects. On one night you may note that stations from one direction are received with considerable intensity. The next night stations in the opposite direction occupy the center of the stage.

UNDER theoretically perfect conditions, stations are heard best when they are in the direction opposite the free end of your antenna. If you particularly desire to receive certain stations, try the effect of an antenna pointing away from these stations.

The uncertainty about distant radio reception has one redeeming feature—if the uncertainty didn't exist, thousands of radio fans who now sit up all hours of the night trying to get distance would find that their hobby had lost one of its greatest fascinations!

New Ideas *for* Radio Fans

How to Get C-Current from B-Eliminator, Cut Out "Motorboating," Decide Correct Antenna Length, and Other Hints

THE popularity of the B-battery eliminator, coupled with the growing use of one of the power type tubes in the last audio amplifying stage of the radio set, has brought up the question of what to do about the C-battery. Power tubes require from nine to forty volts of C-battery. The current consumed in the C-circuit amounts to so little, however, that the life of a dry cell battery used on this circuit is just about as long as it would be if it stayed on the dealer's shelf.

You can solve the C-battery problem either by using a dry cell battery of the proper voltage and employing the B-eliminator for B-voltages only: or you can, under certain conditions, obtain both B- and C-current from the B-eliminator. The separate battery on the C-circuit is the simplest and surest method.

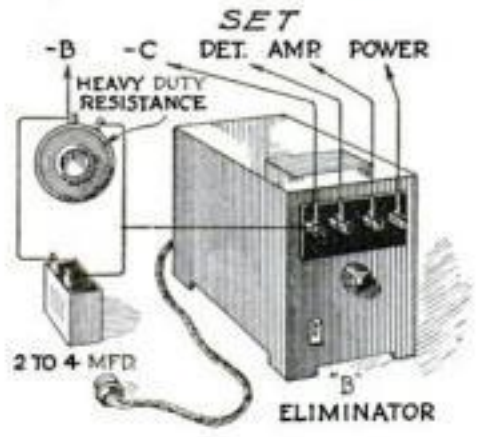


Fig. 1. How to get C-voltage from your B-eliminator by using a variable resistance and condenser

If you want to get the C-voltage from your B-eliminator, try the circuit shown in Fig. 1. The heavy duty resistance shown in the diagram should be capable of carrying at least fifty milliamperes without serious overheating, and it should have a total resistance of about 2,000 ohms if you require a C-voltage of from twenty-seven to forty. The fixed condenser shown should have at least two mfd. capacity; lower values of capacity may cause some hum. With this circuit the C-voltage is, in effect, subtracted from the B-voltage available on the power binding post of the eliminator. Consequently the arrangement is practical only with the more powerful types of B-eliminators.

After you have hooked up the apparatus as shown, set the knob so that the resistance is all in use, snap on the radio set and B-eliminator, and then slowly turn the knob until volume and tone quality are best. Don't turn the knob any farther than necessary to get proper volume and quality, because if you cut the resistance down too far the C-voltage will be too low and the life of the power tube shortened materially.

This apparatus will work on any type of power tube, the only difference being that on tubes that require relatively low C-voltages, you will have to turn the knob farther from the high resistance point.

Don't Burn Wiring

IN WIRING a radio set you are sure to run into places where it is almost impossible to get the soldering iron in contact with the wires you want to solder without pressing the hot body of the iron against the spaghetti tubing or other insulation on adjacent wires. Burning the insulation in this way can be avoided by constructing a simple shield (Fig. 2) consisting of a roll of sheet asbestos tied with wire that can be slipped on the iron while you are working in tight corners. Do not leave the covering on the iron longer than necessary to make the difficult joint. If left on too long, the iron may burn out. Putting the cover on the iron when you first turn it on will help in heating it up.

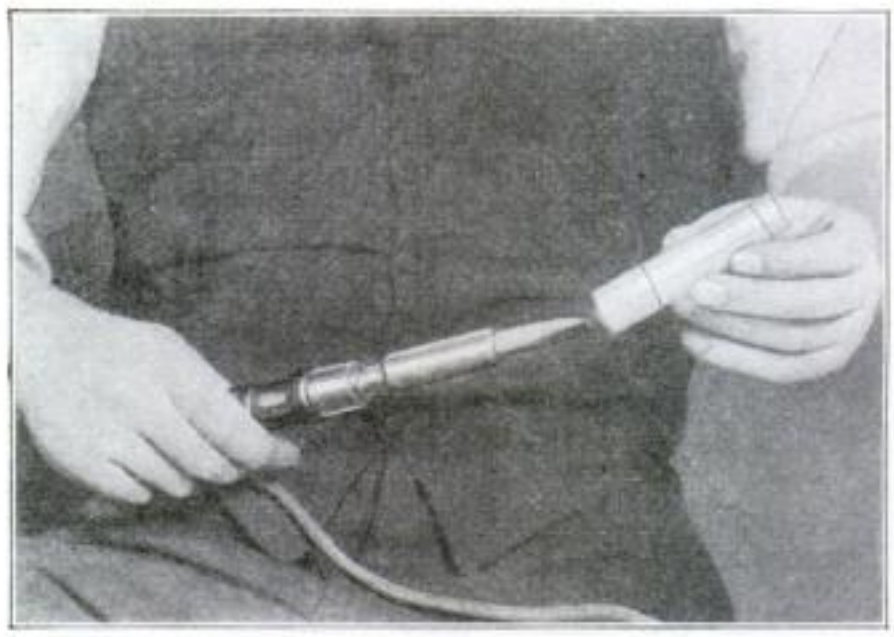


Fig. 2. Use an asbestos shield on your soldering iron, as shown in the photo, when working in tight places to prevent burning the insulation from adjacent wires

How to Stop "Motorboating"

DIFFICULTY often is experienced in operating a set equipped with a resistance coupled type of audio amplifier by means of a standard B-battery eliminator. Either the quality is poor or there is that peculiar "put-put-put" effect nicknamed "motorboating." Increasing the condenser capacity of the B-eliminator, as shown in Fig. 7, sometimes effects a cure. Use condensers having a rated working voltage higher than the maximum developed by the eliminator. Adding capacity also will improve the quality.

If the motorboating persists even after the extra condensers are connected in the circuit, try reducing the value of the resistance of the grid leak on the power tube. This can be done simply enough even when the resistance coupled amplifier is of the inclosed type, by fitting an extra grid leak clip as shown in Fig. 4. Locate the grid terminal of the power tube. It always is the contact on the socket nearest to the contact pin on the base of the tube counting to the left. In other words, when you are looking down into the receiver the grid prong of the tube is just to the left of the pin on the side of the base.

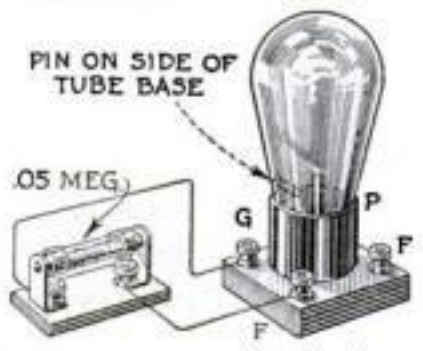


Fig. 4. Lowering the grid leak helps stop "motorboating"

A .05 megohm grid leak in the clip will be in parallel with the grid leak inside the unit, and you will not find it necessary to go lower than this value. The correct value for the extra grid leak is as high as possible while yet stopping the motorboating.

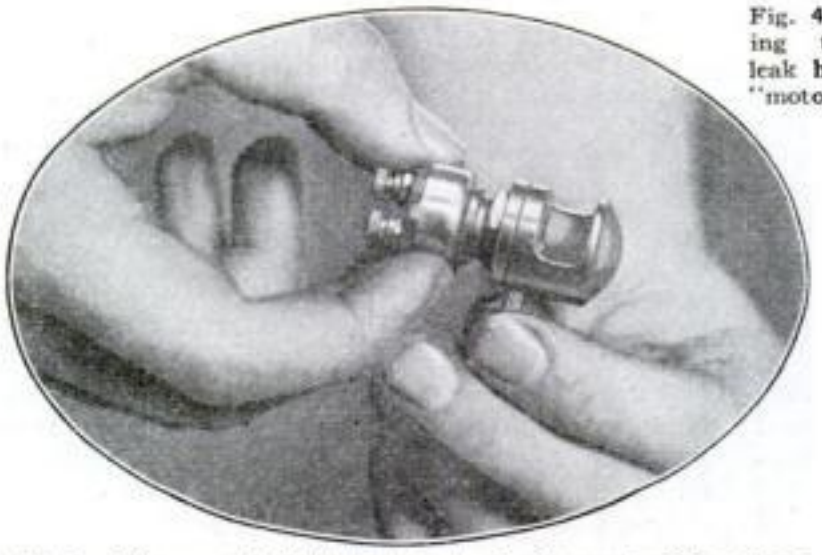


Fig. 3. This new style dial light includes the filament switch and can be added to your set without increasing the number of panel holes

Light for Your Dials

MANY types of commercial receivers are now made with special arrangements for illuminating the dials. Special

dials with lights built in are available to the home constructor of radio sets. In addition, there are several styles of panel lights that can be applied to sets already constructed to obtain the same effect. One of these is shown in Fig. 3. In this particular model the panel light also performs the function of the filament switch so that you can substitute it for the filament switch on the panel and thereby save drilling new holes. A knurled knob turns the light and the tubes in the set on and off in the usual way.

Wire Skinning Pliers

DURING the days when bare bus wire was most popular for wiring radio sets, any type of pliers was satisfactory. The fashion now is to use insulated wire. Consequently time must be spent scraping the insulation from the end of the wire at each joint or connection. You can save yourself this trouble by fixing your wire cutters so that they will serve to skin the wire. Take a sharp-edged oilstone, and stone a little groove in each cutting edge just deep enough so that when the jaws of the cutter are tightly closed they will not cut bare wire of the size you intend to use. To skin the end of a piece of wire, place the end at the notched point, close the pliers and pull. The insulation will be cleanly stripped off. You will find that there is room for several notches of different sizes to correspond with the various wire sizes you use without spoiling the pliers for ordinary use.

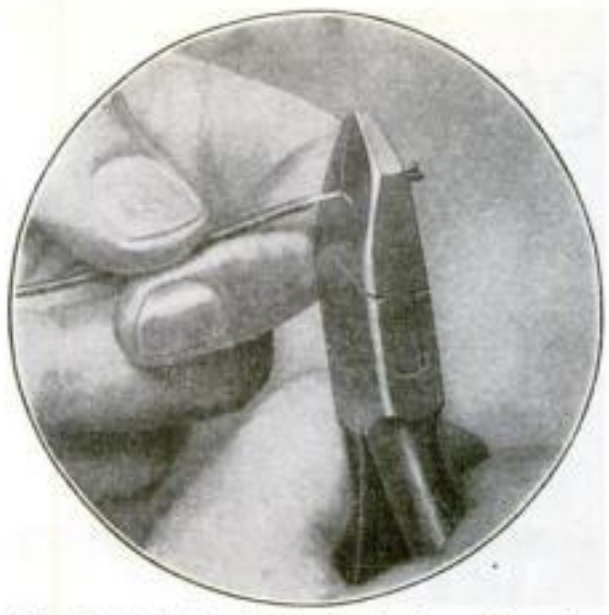


Fig. 5. Stripping the insulation from the ends of wires is quick and easy if you stone notches of the proper size in your wire cutting pliers

As shown in Fig. 5, the best location for these small notches is near the plier joint, so that the ends of the cutting blades will be available for regular use whenever they are needed.

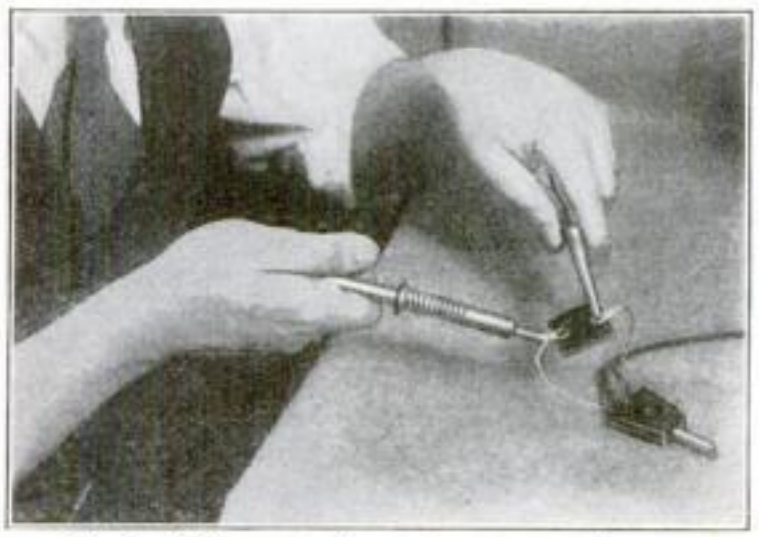


Fig. 6. Adding a fixed condenser across the loudspeaker sometimes improves tone quality

Try This to Improve Tone

SOMETIMES a worth while improvement in tone quality can be obtained by connecting a fixed condenser across the loudspeaker terminals as shown in Fig. 6. Capacity at this point in the radio circuit tends to reduce the strength of the audible tones at the upper end of the scale. In other words, a condenser across the loudspeaker terminals reduces hissing noises to a marked extent, shrill tinny musical notes are subdued, and the lower tones are not affected to any noticeable degree. If you prefer the deep-throated effect, you can get it by a condenser arranged in this way.

The value of the condenser depends on a number of factors, so that the best way is to try several until you strike one that works best according to your own ears. A condenser of .0005 mfd. is about as small as will accomplish anything at this point, and you cannot go beyond .01 without causing a considerable loss in volume. Small pieces of wire can be soldered to the lugs on the condenser and inserted in the plug with the loudspeaker cord tips.

Cutting Out Electrical Interference

THE question as to whether anything can be done about eliminating scratching and hissing noises produced by local electrical machinery depends upon the nature and location of the machinery causing the disturbance. The general impression is that reducing the length of the antenna or using a loop will improve matters, but this is not true in all instances. If, for instance, the interference is caused by machinery located in the same building with you, putting up a longer and higher outdoor antenna may effect a considerable improvement. In this case the ratio of signal strength to the strength of the interference is changed for the better. It is also a good idea to change the location of your antenna if that is possible. Interference produced by machinery outside your own building may be reduced by the use of a shorter antenna, especially if you can move the antenna farther away from the source of the noise.

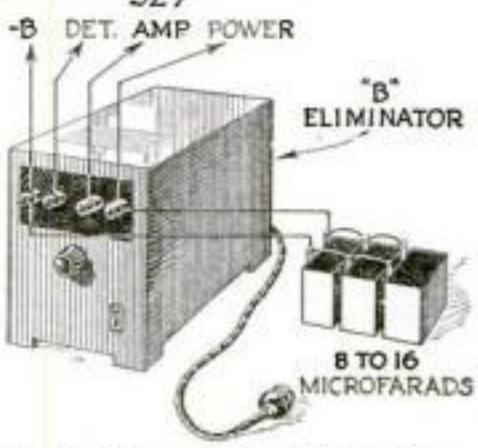


Fig. 7. Extra capacity added to eliminator stops "motor-boating"

Often, however, nothing at all can be done to improve matters. If you live near a trolley line and scratching noises are produced every time a trolley goes by, the only remedy is to move away.

To Increase Selectivity

ANOTHER use for small fixed condensers is to increase the selectivity if you find difficulty in separating stations on adjacent wave lengths. The simplest way to connect a condenser at this point is shown in Fig. 8, and this illustration as well as the one in Fig. 6 shows the correct way to hold a small fixed condenser while soldering a wire to one of the lugs. The condenser always should be grasped by the pliers on the metal part opposite the side where the lug is being soldered, as otherwise the metal of the pliers absorbs the heat from the metal of the condenser and prevents it from getting hot enough to take the solder.

In order to obtain any appreciable increase in selectivity with a series antenna condenser, very small capacities must be used. Try .00025 mfd. and then .0001. If the results still are not satisfactory, use two .0001 condensers in series.

The effect of a series condenser used in this way is somewhat the same as cutting down the length of the antenna. Consequently, soldering a condenser as shown is desirable only if you want to effect a permanent increase in selectivity as might be the case if the only available place for the antenna resulted in too long a stretch for best results in your particular locality.

A condition exactly the reverse of this, that is, where you are located far from the broadcasting stations and you can erect only a short antenna, requires different treatment. In this case selectivity is of less importance, while signal strength is what you are after. Frequently a considerable increase in signal strength can be obtained by adding a coil of wire to the antenna circuit in place of the series condenser. The number of turns will depend on the length of the antenna you are using and also on local conditions which govern the natural wave length of the antenna. Try twenty-five turns of ordinary well wire bunched into a coil roughly three inches in diameter.

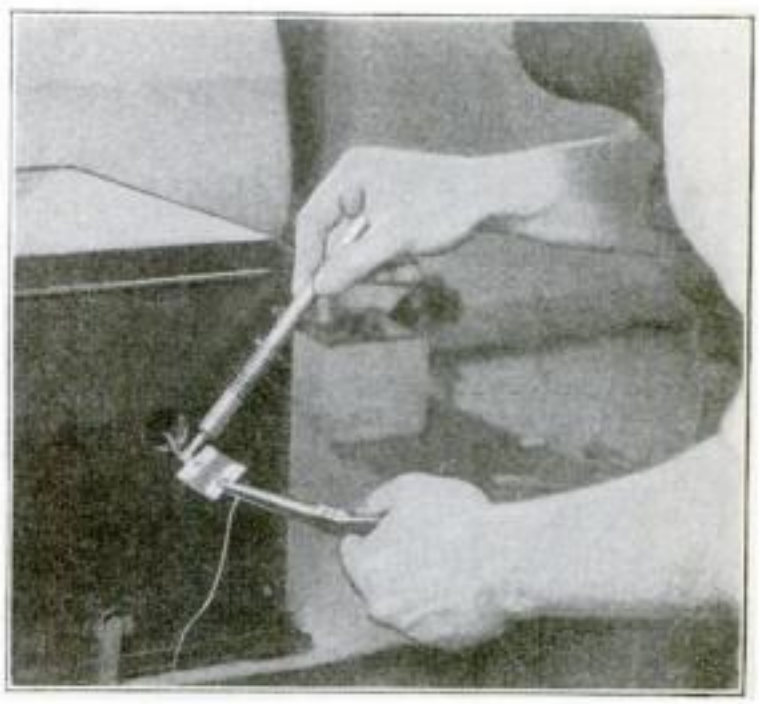


Fig. 8. The selectivity of a long antenna can be increased by connecting a condenser in series

A Compact Radio Set

Where neighbors are close and space is limited, try this outfit

By JOHN E. LODGE

The volume of protests from neighbors depends in inverse proportion on the kind of music inflicted on them. Excellent tone quality is possible from a small outfit

"IF SOMEBODY doesn't murder that bird pretty quick, I'm going to do it myself!" shouted the irate occupant of the third floor back. The rest of the boarders unanimously agreed that violence was called for—the sooner, the better.

Meanwhile the cause of the impromptu indignation meeting was lolling back in his armchair enjoying the hideous wails and thumpings of a fourth-rate jazz orchestra rumbling forth from an antiquated tin horn type loudspeaker.

His situation was not unusual. Countless other dwellers in boarding houses and hotels, actual or potential radio fans, are faced with the same difficult problems in their search for adequate radio entertainment.

One of the most important is good tone quality. The volume of protests from neighbors depends in inverse ratio on the kind of music inflicted on them; the better the music, the fewer the kicks.

Luckily, it is possible to obtain excellent tone quality from a reasonably small and compact outfit that will take up little space and be easy to move when the time comes for a shift to another residence. You don't want great volume anyhow, because you are bound to have some neighbors across the hall who don't care for music of any degree of excellence. Besides, with low volume requirements you do not need the larger power tubes which call for extremely high B-battery voltages.

Everything considered, you will find that the 199 type tube has the most favorable characteristics if size and portability of the receiver and incidental equipment are important. With 199 type tubes in all of the sockets of the set except the last, in which you should use a 120 type dry cell power tube for the sake of quality, the receiver can be made small and the heavy, six-volt storage battery needed to supply the filament current for the larger types of tubes is not necessary.

You can run a set fitted with several 199 tubes and one 120 tube on three ordinary No. 6 dry cells, such as are connected to the door bell; or if the places where you expect to live are supplied with electric light current, you can buy an A-power outfit consisting of a small, light, two-cell, four-volt storage battery and a trickle charger.

FOR a B-battery you will need medium duty, forty-five-volt blocks of dry cells and one twenty-two-and-one-half-volt block to use as a C-battery. Still further economy in supplying current to your set can be obtained by the use of several sets of three dry cells each connected in parallel to light the filaments; if you use the set an average of several hours a day, a small, high grade B-battery eliminator will save space and money.

The size of the set and life of the dry cell A-batteries and B-batteries depend on the number of tubes in the set; consequently it is better to purchase or build a set with the fewest number of tubes consistent with the results you want to obtain.

Most of the standard types of radio sets now on the market can be used with 199 type tubes. In fact, all modern radio sets are made with sockets of the UX type which will take the new types of either storage battery or dry cell tubes.

While the larger types of cone loudspeakers give remarkably perfect tone quality, you may not have space for such an instrument and, besides, a large cone requires extreme care in handling. It would prove a nuisance to pack and move from one place to another. Horn type speakers are more rugged but have the disadvantage of poor tone quality, especially in the smaller sizes. One of the small size cones would appear to be the best selection. If it is absolutely necessary to keep the size of your equipment to the lowest possible minimum, you can dispense with the loudspeaker entirely and use a phonograph loudspeaker unit fastened in a corner of the ceiling with the diaphragm toward the corner where the ceiling and two walls meet. Quite acceptable results can be obtained in this way both for volume and quality.

OF COURSE, if you do your receiving with a pair of headphones, a great saving is effected in the size, weight and cost of your whole radio equipment. In addition, you certainly will never annoy the most sensitive neighbor.

You will need some kind of antenna unless you purchase an expensive, loop-operated set. If you cannot get permission to put up a temporary outdoor antenna, string a piece of bell wire around the picture molding in your room.

Sam Loyd's New Puzzles

How Fast Can You Think?

Seven Brain-Teasers to Check Your Abilities

Have You Imagination?

"*A hundred and fifty when joined to a tree*
Makes a fine garment to warm you or me."

That couplet fits the picture above and poses a riddle. What cozy-sounding garment is suggested by the sketch?

Rebuses and riddles are a test of your wit and imagination. Try to solve this as quickly as possible, then turn to page 139 for your rating.

Can You Analyze Facts?

FOUR little girls and their four brothers divided thirty-two apples among themselves as follows: Ann got one apple, May two, Jane three, and Kate four. The boys' innings were more complicated: Ned Smith received as many as his sister; Tom Brown twice as many as his sister; Bill Jones three times as many as his sister, and Jack Robinson four times as many as his sister.

From these facts, can you figure out what must have been the surnames of Ann, May, Jane and Kate? Aside from the elementary mathematics involved, the problem calls for ability to pursue analysis beyond orthodox formulas. The solution is found on page 139.

Are You Quick at Figures?

"THE call for a standing vote, Mr. Chairman," reported the secretary at the Rotary Club meeting, "showed that the motion was carried by a plurality equal to one third of the opposition. But as that result, it develops, was due to a lack of chairs, preventing eleven members from sitting down to register their votes in the negative, we wish to report that the apparent minority actually defeats the motion by one vote."

From the secretary's report, can you tell how many votes were cast, pro and con, and prove your quickness at figures. Find your rating on page 139.

One for Mental Bookkeepers

TWO sisters have found it an agreeable plan to pool their allowances and do their shopping together. On one of their recent visits to the stores, Martha bought a hat and a pair of shoes for $15. Then Gertrude paid as much for a blouse as Martha did for her hat, and invested the remainder of their money in a parasol for herself.

On the homeward trip, Gertrude, who had been "thinking over" a remark of Martha's about her blouse's costing as much as Martha's hat, called attention to the fact that Martha's shoes had cost $1 more than Gertrude's parasol. "That's true," agreed Martha, "and if we had apportioned the blouse and shoe money so as to make your blouse cost half as much again as my shoes, then our total expenditures would have been equal, 'fifty-fifty,' as the boys say."

From the facts given, if you have an aptitude for analytical bookkeeping, you should be able to give the respective costs of the four purchases in a few minutes. Time yourself, then turn to page 139.

SAM LOYD, the world's most famous puzzle man, offers these brain-teasers from month to month in POPULAR SCIENCE MONTHLY in response to requests from hundreds of readers. To use them as real tests of your mental ability, time yourself in solving them and compare your time with the ratings on page 139.

Are You Observing?

IN THIS seesaw, the balance point is exactly in the center of the beam, and the elves are teetering in exact balance. Now, if all the boys in the two groups were seated on one arm of the seesaw, how many girls would it require on the other side to effect a perfect balance? Of course it must be assumed that boys weigh alike and girls weigh alike.

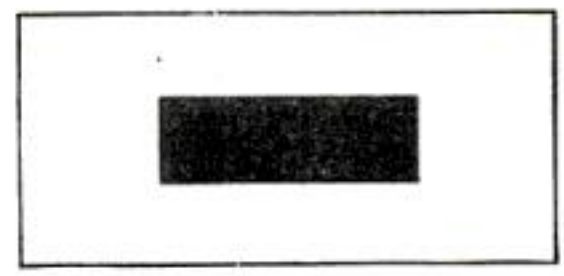
Your speed at solving this will test your aptness at grasping and resolving visible evidence. Turn to page 139 for your rating.

A Test of Vocabulary

WHEN a puzzler "beheads" a word, he removes the first letter. Here, then, is a test of your vocabulary and quickness in visualizing words. Behead:

A word meaning to desire and leave one meaning to act irrationally; a wooden case and leave a price; a tale and leave efficient; a measure and leave indisposed; a limb's extremity and leave a conjunction; an injury and leave a limb; a culinary concoction and leave a residue; part of a boat and leave a marine creature; a scoundrel and leave the middle of a church.

Time yourself, then turn to page 139.

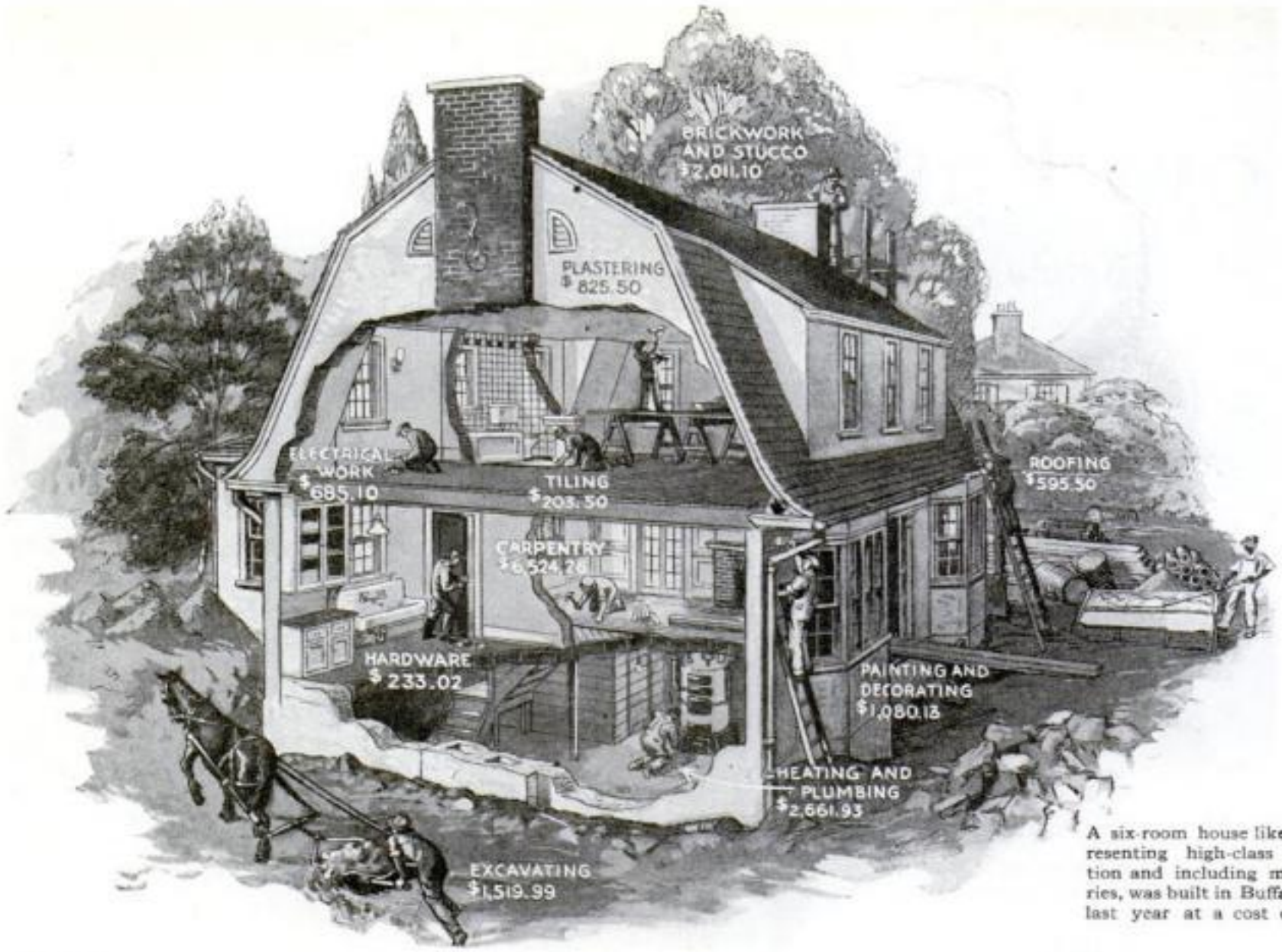


Have You Keen Sense of Form?

ABOVE is a design suggested for the battle flag of the Zulu Navy. From a puzzler's standpoint, the advantage of the design rests in the fact that when the Zulu ship is ready to surrender and send the symbol of defeat to the maintop, a square white flag can be nicely constructed from only two pieces cut from the white parts of the battle flag.

Discard the rectangular dark central section. Then divide the remaining white part into halves, of exactly the same shape, which will fit together to produce the white square.

This is a rather difficult test of your sense of form and proportion. Time yourself, then refer to page 139.



A six-room house like this, representing high-class construction and including many luxuries, was built in Buffalo, N. Y., last year at a cost of $16,600

What It Costs to Build

Facts and Figures about Materials and Labor That Will Help When You Plan to Construct Your House

By

JOHN R. McMAHON

MY TAILOR is building a house. The other day he asked what I would think of him if, when I asked when a suit would be ready and what it would cost, he replied: "Maybe in a few weeks, maybe some time next fall. I never promise any time. Don't know the cost exactly, fifty or seventy-five dollars, perhaps. It might even turn out to be a hundred dollars."

I told him I'd think him crazy.

"I am having a house built," he said with a grin, "and I'm just trying out on you the line of talk the building people give me. I can tell customers that buttons, lining and wages may go up or down; that I couldn't promise a delivery date because unexpected conditions might arise. But I don't. Why isn't a house like a suit of clothes?"

Rightly or not, many persons share the critical sentiments of my tailor in regard to home building. "What will it cost?" is something of a popular riddle, and there are many obvious reasons. Houses differ greatly in themselves and in the conditions under which they are built. Most of them are individual hand jobs. Their materials are retailed at all sorts of prices and wages vary widely between Mobile, Boston and Seattle.

But there are two common methods of estimating house cost. One is based on surface area, or square feet; the other on volume, or cubic feet. Both are rough but useful.

In estimating by the volume method, you multiply length, width and total height of building from cellar floor to roof. Add roof contents in cubic feet: for an ordinary peak, the roof contents would be half the roof height at ridge multiplied by length and width. Dormers can be treated as small peaks, figured separately. Finally, multiply the total volume by the cost per cubic foot of that type of dwelling.

SOME idea of the cost per cubic foot of different types of dwellings may be had from the following figures, covering an eastern metropolitan area last year (they do not include contractor's profit, which may amount to ten percent more): Bungalow of three or four rooms without basement, 32 cents per cubic foot; frame dwellings built by a speculator, 40 cents; a stucco residence, 43 cents; brick house termed semifireproof, 44 cents; rather high class masonry dwelling, 49 cents. It may be interesting to compare with these figures, 28 cents for a garage, 54 cents for an apartment house, 63 cents for an office building and 92 cents for a first-class hotel.

IN ESTIMATING the house cost by the area method, outside walls are considered. Using this method, one expert offers 61 cents as the square foot cost (minus contractor's profit) of an outside wall in wood frame, with sheathing, paper, siding, lath and plaster inside and three coats of paint outside. A similar wall with shingles instead of siding costs two cents a square foot more. If the outside covering of the wood frame wall is stucco on metal lath, the price jumps to 86 cents a square foot. Some of the extra expense is due to the high grade waterproof paper under stucco, also furring labor and material. Frame with face brick veneer amounts to 97 cents, while a solid eight-inch wall of common brick, furred and plastered inside, is only 86 cents. Hollow tile, eight inches thick, stucco outside and plastered directly inside, is 93 cents. Concrete block costs something less than hollow tile. While

the figures show a large difference as to outside wall costs, it is asserted that, in relation to total building cost, masonry is only six or eight percent more expensive than wood frame.

L. H. OLSON, vice president of the American Appraisal Company, tells me that his concern uses neither the ordinary volume nor area method described, but bases its cost estimates on wall perimeter and living floor space. Wall perimeter means simply circuit measure. Living floor space excludes all nonliving space, such as the attic, basement or elsewhere. All bathrooms, recreation rooms and finished rooms in general belong within the definition. On this basis, Mr. Olson estimates the cost of a present-day house at $5 to $8 for each square foot of living floor space. Thus a house 30 by 35 feet, inside measure, two floors usable, would cost $10,500 at the lower rate and $16,800 at the higher figure, which calls for more expensive material and workmanship.

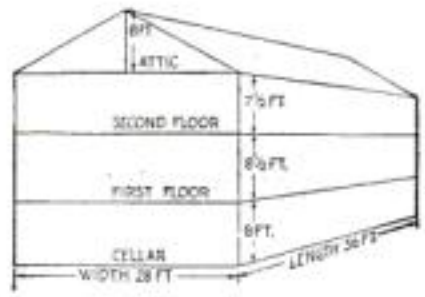
These figures check up fairly well with others based on building area. The actual cost of a first-class dwelling was found to be $15.60 per square foot of building area, the detail costs per square foot of building area being as follows:

Excavation	$0.25
Masonry	2.00
Rough framing (wood, metal lath and stucco)	4.25
Interior finish	5.90
Plumbing (brass pipe for water supply)	1.30
Heating (hot water, coal furnace)	1.05
Electric lighting, with fixtures	.85
Total per sq. ft. building area	$15.60

Cutting in two the interior finish item, which in this house included rare and luxurious details, the house belongs in the class previously described as worth $8 per square foot of livable area.

A NUMBER of so-called model houses were built last year in various parts of the country by the coöperative action of newspapers, trade interests and various architectural institutions. One of these was constructed at Buffalo, N. Y., having six rooms, the materials being brick, half timber, stucco and siding. Its cost was distributed thus:

Excavation and foundation, including garage and cellar floor	$1,519.99
Carpentry and millwork; California white pine for exterior and inside trim; fiber board insulation; hardwood floors	5,737.35
Plaster, three coats on fiber insulating lumber	825.50
Brickwork and stucco outside, three coats; open fireplace; incinerator with chimney	2,011.10
Tiling, bathrooms, hearth	203.50
Plumbing, brass pipe for water supply; automatic gas heater for hot water	1,029.68
Heating, steam; oil burner	$1,632.25
Roofing, asphalt shingles; copper flashing, gutters and leaders	595.50
Electrical work	685.10
Windows, steel frame; plate glass; weather stripping	786.91
Hardware, locks, etc.	233.02
Painting and decorating, including linoleum	1,080.13
Kitchen equipment, gas range	230.00
Window shades and screens	84.28
Total labor and materials	$16,654.31



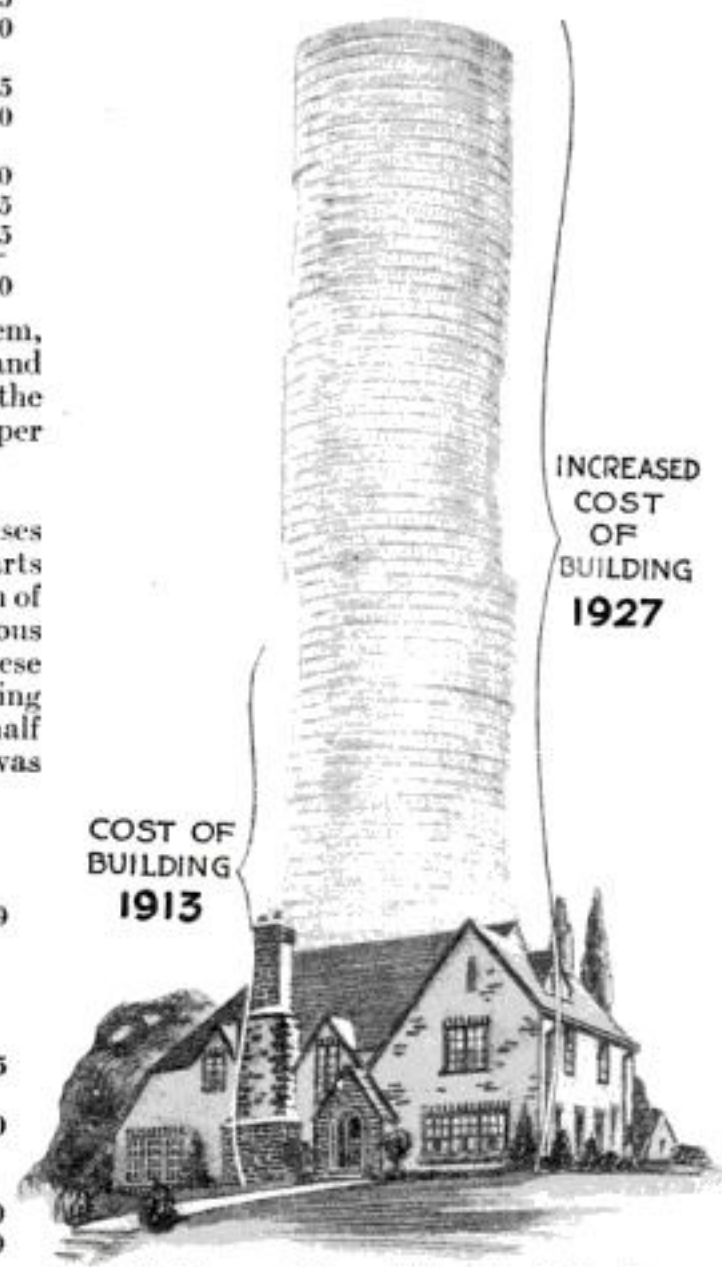
How to Figure the Cost of a House on a Basis of Its Cu. Ft. Capacity

FIND total cubic foot capacity; multiply this by the accepted cost per cubic foot for your locality. For example, taking the above house:

House below attic, 28x36x24 = 24,192 cu. ft.
Roof, 28x36x4 (½ height) = 4,032 cu. ft.
Total capacity, 28,224 cu. ft.

Total cost in frame, 28,224 × $ .40 = $11,289.60
" " " stucco, " × .43 = 12,136.32
" " " brick, " × .44 = 12,418.56

(These cost-per-cubic-foot figures, 40, 43 and 44 cents, are accepted costs in an eastern metropolitan area.)



With building materials and labor doubled and even tripled since 1913, a house built today costs at least twice as much as the same house built before the war

These figures do not include the architect's fee, contractor's profit and various sundries. It may be noticed that little was spent on the roof compared with the heating plant. Other items, also, might be adjusted to personal preference.

IN INTERESTING contrast with the Buffalo house is another six-room house erected under like auspices in a suburb near New York City. Though specifications for both houses were about the same, labor and materials for the second house cost $2,500 more. Excavation and foundation were $150 less than for the Buffalo house; carpentry and millwork costs were almost identical; while inside plastering cost $345 more on the Atlantic seaboard than on the shores of Lake Erie. Such a substantial difference must be attributed to the wage factor. Brickwork and stucco outside were $61 higher at the seaboard location. Extra tiling in the latter case—in bathrooms up to the ceiling and in kitchen up to a height of four and one half feet—accounted for $900 more on this item. Plumbing was $333 higher on the coast.

Heating with oil burner was $554 more expensive, but this difference can be explained by the installation of a hot water system instead of steam. Roofing of the same sort was about $100 less in the eastern district, and this difference was almost precisely reversed on the item of electrical work. Windows of steel frame were $63 higher on the seaboard.

Hardware was $132 cheaper on the first dwelling, but this item has a wide variance anywhere on account of quality. Painting and decorating were $182 less in the metropolitan area.

THE last item, window shades and screens, seems to reveal a startling extra charge of more than $300 for the suburbs of New York. However, the specification of bronze wire screening in the latter case goes a long way toward explaining the cost. It would still appear that with an allowance of $2 per shade, the screen doors and window screens of this house would cost between $8 and $10 apiece.

Knowing the price of materials and the rate of wages, the big question remains, how much can the worker accomplish per hour or day? Quality counts in building a house, and a too hurried job is bound to be poor. Nevertheless an approximate estimate of what one able-bodied man can accomplish *in one day under average conditions* is helpful, and is offered as follows:

Excavation, pick and shovel	1.25 cu. ft.
Rubble or fieldstone masonry	40 cu. ft.
Concrete, hand mixed and placed	54 cu. ft.
Cellar floor, concrete	10 sq. yds.
Cutting blue- or limestone	7 sq. ft.
Bricks, common, 8-in. wall; with helper	850 bricks or 56 sq. ft.
Face brick	425 " " 28 " "
Concrete block,	

(*Continued on page 137*)

Useful Ideas *for* Your Car

Air Moistener, Battery Handle, and Other Ingenious Kinks

UNLESS you are equipped with a special jack designed low enough so that it can be placed under the axle when a balloon tire goes flat, you may find it extremely difficult to change tires. If you get stuck this way, your spare tire may solve the problem. Simply place it in front of the flat tire as shown in Fig. 1, drive the car ahead till the flat tire rolls on to the spare, and then slip the jack under the rear axle. Working the jack lever takes the weight off the spare tire so that it can be exchanged for the flat one.

Fig. 1. Using the spare tire to help get the car on the jack if you have difficulty getting the jack under the rear axle

Saving Your Springs

WHILE the best possible insurance against spring breakage is a set of properly adjusted recoil snubbers, you will find that fabric belts clamped around the axle and the frame as shown in Fig. 2 are worth while. The belts will not interfere with the free action of the spring when a bump is encountered, but when the car starts to bounce too high, they will prevent bending the springs the wrong way so far that they break. If your car has a tendency to excessive up and down wobble when you hit a succession of bumps, special clamps, like spring clips, fitted with leather friction pads, can be used to increase the friction between the leaves and in this manner deaden the spring action.

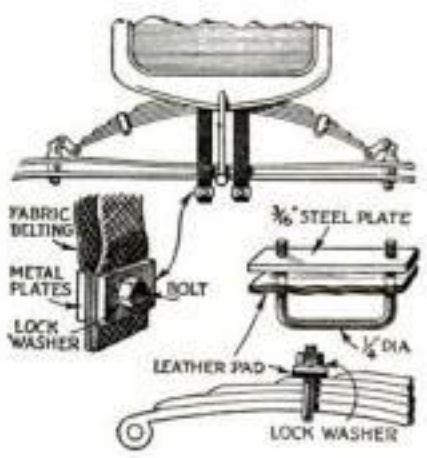


Fig. 2. Fabric straps as shown above will prevent excessive rebound and keep your springs from breaking. Special C-clamps stop the bouncing

Old Rim As Hose Rack

THE short piece of hose that you keep in the garage to wash the car can be kept in good condition, handy and yet out of the way, by bolting an old rim to the wall near the water tap as shown in Fig. 3. Almost any old rim will provide ample space for the short piece of hose that is ordinarily used in the home garage.

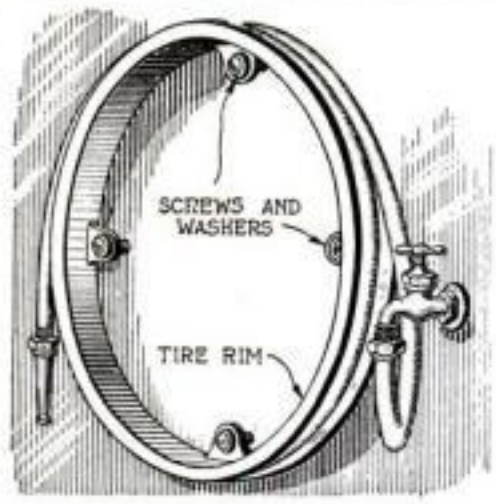


Fig. 3. The hose you use for washing the car can be kept out of the way and where it is handy, with a reel made of an old automobile rim as shown above

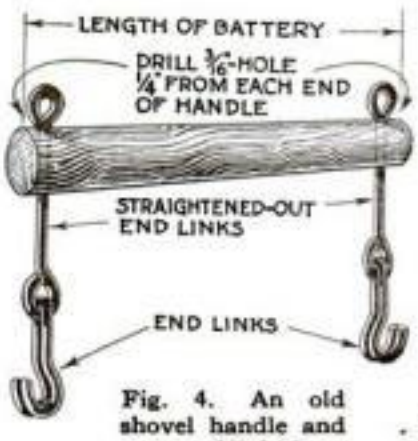


Fig. 4. An old shovel handle and some end links from an old skid chain can be made into the storage battery handle shown above

Simple Battery Handle

FIGURE 4 shows you how to make a simple handle that will fit almost any storage battery. It is made from a stout piece of wood, such as an old shovel handle or fork handle, and the end links are from an old cross chain. After the holes are drilled at each end, two links are straightened out and passed through the holes.

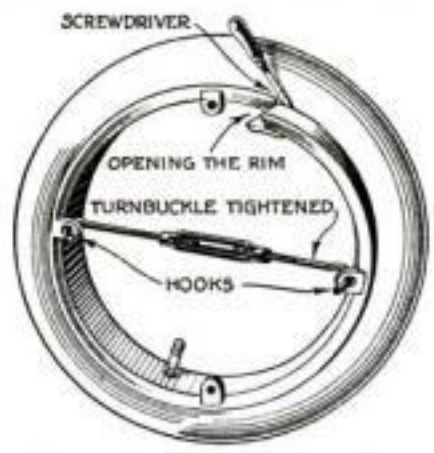


Fig. 5. A turnbuckle used as shown here will enable you to remove a tire easily, even though it is badly rusted on to the rim

Fig. 6. (Right) An emergency way of closing up rings to get the pistons into the cylinders

Turnbuckle Compresses Rim

IF YOUR car is fitted with rims on which the lugs are part of the rim, a good sized turnbuckle can be used to compress the rim and allow you to take off a tire even if it is badly rusted. While it is better to use a large turnbuckle, a small one will do if you piece out from the turnbuckle eyes to the lugs by means of hooks of the proper length. Fig. 5 shows how the turnbuckle is used.

To Close Piston Rings

IF YOU find it necessary to fit new, stiff rings and you have no ring compressor, a string arranged as shown in Fig. 6 will permit you to do the job without trouble. Tie the end of the string to any convenient bolt, pass it around the ring and pull on the handle.

Air Moistener

ONE of the objections to the ordinary way of building a moistener for the air that goes into the manifold of your motor is that there is a chance, when the car goes over a bump, of the water's splashing up and being drawn into the manifold in the liquid state. By building your air moistener in two mason jars as shown in Fig. 7, the second jar acts as a water trap. In operation, the suction of the manifold causes a constant stream of air to flow from the nozzle in the first jar and come up through the water in the form of fine bubbles. The amount of water vapor absorbed by the air is in proportion to the size of the bubbles; the smaller the bubbles, the more nearly the air drawn through the jar approaches the saturated state.

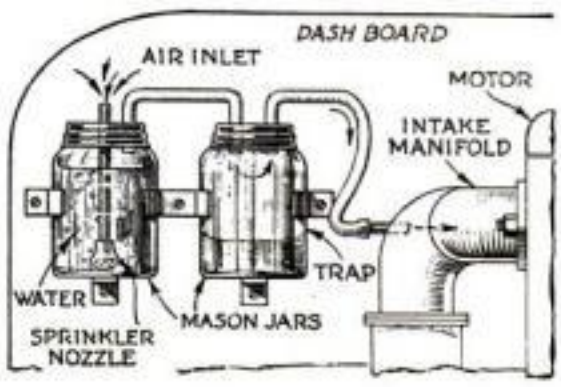
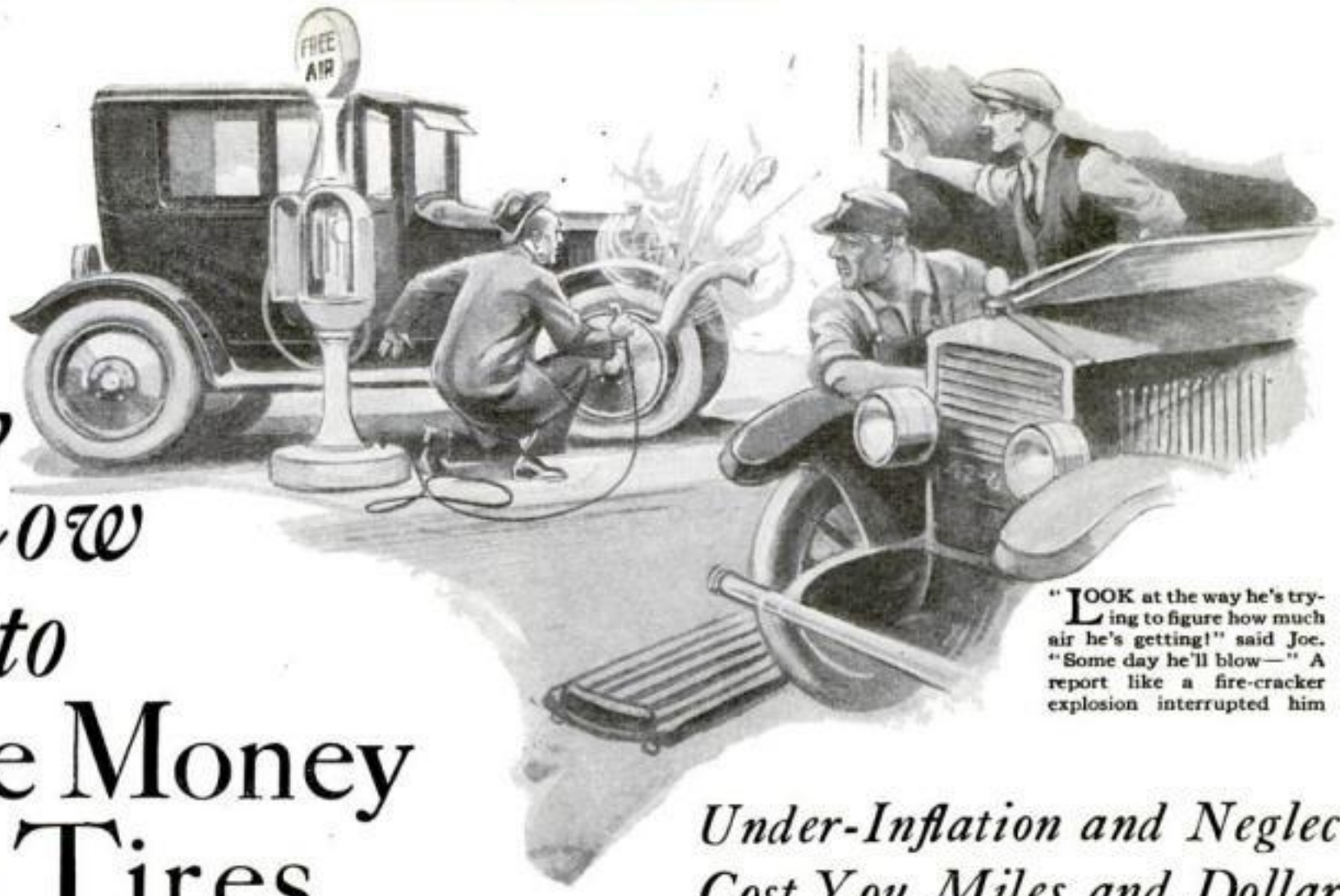


Fig. 7. Ingenious arrangement of two mason jars to serve as an air moistener. The second jar prevents any of the water from being drawn into the cylinders

M. L. BURGHAM, of Parnassus, Pa., wins the $10 prize this month for his suggestion of an air moistener (Fig. 7). Each month POPULAR SCIENCE MONTHLY awards $10 in addition to regular space rates to the reader sending in the best idea for motorists. Other published contributions will be paid for at usual rates.



"LOOK at the way he's trying to figure how much air he's getting!" said Joe. "Some day he'll blow—" A report like a fire-cracker explosion interrupted him

How to Save Money on Tires

Under-Inflation and Neglect Cost You Miles and Dollars

By MARTIN BUNN

"OLD BURR sure has a permanent cramp in his pocketbook," grinned Joe Clark to his partner, Gus Wilson, as their departing customer let in the clutch and drove away from the Model Garage. "He's penny-wise and pound-foolish," observed Gus. "Our prices on tires are reasonable and we don't palm off stale stock. Just wait till he gets stuck good and plenty on a 'gyp' tire, then we'll have him for a regular customer!"

About a week later, Burr pulled up in front of the Model Garage near the air pump and proceeded to apply the hose to his tires. There was a new shoe on his right front wheel, Gus noted.

"I've tried to sell him a tire pressure gage," said Joe. "The old tightwad won't buy one. Just look at the way he's trying to figure how much air he's getting! Kicking the tires won't tell him anything. Someday he'll blow—"

A report like a fire-cracker explosion interrupted him. Burr in an instant was enveloped in a cloud of dusty tire talc.

"By Jinks, he's gone and done it!" The two men rushed over to Burr, who was vainly trying to dig the dust out of his eyes. Apparently the tire had torn loose from the rim and the blow-out had ripped a five-inch piece out of the tube. Both the new shoe and the tube were completely ruined.

"I'LL have the law on 'em for selling me a dangerous article," blustered Burr when he had recovered from his amazement. "They guaranteed that tire, and I'll see that they make good!"

"If you do," soothed Gus, "it will be the first time I ever heard of a gyp making good on anything. Besides, you can't prove you didn't blow it up too hard, working without a gage."

"But I can tell by kicking when they're getting enough air," protested the angry motorist. "I never had any trouble like this before."

"Your toe must be a lot more sensitive than mine, then," growled Gus. He bent over to inspect the wrecked shoe. "This sure is a gyp 'boloney' for fair. Hardly any wires in the bead—no wonder it stretched over the edge of the rim. And look how thin the rubber is."

"Humph!" snapped Burr. "And how do you account for the fact that I got fine mileage out of the last shoe I bought from that same dealer?"

"Good luck, that's all," Gus answered. "You might have as good luck again if you buy more of his junk tires. But you can take it from me, when a man sells you a tire at half the regular price, it isn't worth even that.

"The worst of it is that it takes an expert to tell what's the matter with a cheap tire. It may look all right, but how do you know that it isn't overcured? Or maybe there's a break in the cord fabric under the rubber.

"IT'S all right to talk about 'factory blemished' tires and how there's nothing the matter with them except possibly an 'irregularity in the tread' or that they 'don't look just right,' but you can bet your boots the factory inspectors aren't going to throw out a tire just because there's a couple of fly specks on it. The inspectors are paid for knowing how to find real defects that will shorten the life of the tire, and when they say it's not up to snuff you can take it they're right.

"Of course this tire wasn't even a good factory 'second.' It's just a junk tire made to sell at any price and still give the dealer a big profit."

"Perhaps you're right," admitted Burr, half convinced in spite of himself. "How much did you say you'd charge me for a new shoe with a bit of discount for cash?"

"I'll throw in a really good tire gage as discount," grinned Joe. "It'll save you more dollars than any cash discount."

"I'll take it," agreed Burr. "It seems like a lot of money to be spending on one tire, though."

"Not when you figure it out on a dollars per mile basis. That's all you're getting out of any tire—so many miles of running at so many cents a mile, and if you can get twice as many miles out of a tire that costs only a quarter or a third more, you're making a big saving. If some manufacturer could make tires that would give fifty thousand miles instead of the ten or

What Was Wrong with Markin's Car?

IN THE February issue POPULAR SCIENCE MONTHLY published a story detailing Markin's troubles with his new car, offering a prize of $25 for the best letter explaining the trouble and telling how to overcome it.

Julius C. Lapp, of Orano, Maine, wins the prize. The condenser was short-circuited, and many contestants indicated this as the source of trouble. Of these, Mr. Lapp, in the opinion of the judges, offered the most accurate diagnosis of the trouble and the simplest and most effective remedy.

fifteen you get now, they'd certainly be bargains at a hundred dollars apiece."

"There are other ways you can save money on tires, too," Gus added as he started mounting the new shoe on the rim. "Taking care of them is the best way I know of. First and most important, keep 'em pumped up to the right pressure all the time. Joe'll give you a chart that shows the right pressure. Keep the pressure two or three pounds more than the low limits shown in the table. Also, you want to remember that the weight the tires carry is what determines the amount of air you want in 'em. If you go on a long trip alone, you can get easiest riding qualities by having the air pressure down pretty near the low limit.

"ON THE other hand, if you start out with four or five big, husky chaps in the car besides yourself, and a lot of luggage for good measure, remember to pump the tires hard enough to take care of the extra weight. Three heavy men on the back seat and a trunk strapped on behind may add as much as three hundred pounds apiece to the load on each rear tire, and if the pressure is down to the minimum figured for the weight of the car alone, the extra weight will squash out the tires and the side walls will get too much bending. That means destructive friction in the cord fabric in the side walls of the tire, and if you happen to run over a car track or a brick, you are almost sure to get what is known as a rim bruise. The tire may look all right for quite a while afterward, and then there'll be a mysterious blow out."

"That explains what must have happened to a shoe that blew out last year," said Burr. "It looked like a defect to me, but now that I think of it, there was a slight dent in the rim at that point."

"Sometimes you can dent a rim without damaging the tire," explained Gus, "but a dent in a rim is a bad sign. If you have tried to pound a dent out of a rim, you know how tough the steel is. It takes a thumping hard blow to put a dent in one. That blow is transmitted to the rim through the walls of the tire."

"Then if I keep my tires pumped to the right pressure, my troubles will be over?" questioned Burr.

"MOST of them will be, but other little things can cause a lot of grief. A piece of glass in the road may make a cut in the rubber tread that looks too trifling to bother with. Water gets into the cord fabric through the hole and rots the cords. After a while the tire blows out at that point; or maybe sand works under the tread, raises a blister and eventually ruins a part of the tread.

"Watch out that your tire chains aren't too tight, too. If you don't have them loose enough so that they can creep around the tire, they will cut right into the rubber."

"I don't use chains much anyway," said Burr, "so that doesn't bother me. But what am I supposed to do about those little cuts and things?"

"The safest way is to go over your tires once a week," Gus advised. "If you find small cuts in the tread, fill up the hole with tire dough; if a piece of the tread has been torn away, have it vulcanized before it gets any worse.

"How many miles have you driven this other front tire?" Gus inquired, bending over to inspect the tread.

"What's the matter with it?" countered Burr suspiciously. "It's nearly new. I put it on about a month ago."

"I can tell that by looking at it," Gus laughed, "but I have a hunch that the wheels are out of line. The tread seems to have a rubbed appearance caused by the sidewise slip that always happens when the wheels aren't in line. Have you bumped into anything lately?"

"CERTAINLY not," replied Burr. "That is, I haven't hit anything. About two weeks ago, though, I got into a jam and had to drive up over a high curbstone to save smashing into a car. It jarred the car quite a bit."

"That's what's the matter, then," said Gus. "You must have hit the curb at an angle and the sudden strain bent one of the steering knuckles a trifle. I'll line up the wheels for you right away. You want to watch out that the front wheels don't get any sidewise bumps like that. Even running the front wheel against the curb when you're parking the car will sometimes spoil the alignment. Driving fast in deep ruts is bad, too. Wheels that are out of line as much as a quarter or a half inch will grind off the tread in no time."

"I should think that if the front wheels were out of alignment you would notice it in the steering," observed Burr.

"Not necessarily," Gus replied. "A slight error throws both wheels out a trifle, and the strain is divided between them. Besides that, the steering wheels on modern cars are geared so low to make easy steering with balloon tires that a slight drag would hardly be noticed. The only safe way is to have them checked up occasionally, especially when the front shoes seem to be wearing more than they ought to.

"Here's another point that lots of drivers don't realize. Extra wear is put on the tires if one of the wheels wobbles because the axle is bent or because the rim isn't on straight. This accounts for many queer cases where the tread seems to wear away much more at two points on opposite sides of the tire, remaining unworn at the sections between. You see, each time the wheel turns, a part of the tire moves sidewise as well as straight ahead, and that means extra friction."

"Well!" said Burr. "My neighbor's tires never seem to wear out, and now I think I know why! I notice he's always testing the pressure or looking them over. I thought that was all foolishness and a waste of time, but there may be something in it after all."

"Two things," Gus stated. "First, you save money because your tires actually give you more miles. Second, if you know just how you stand on the tire question, you're not likely to get stuck with a flat tire so often."

Under-inflation causes excessive tread wear

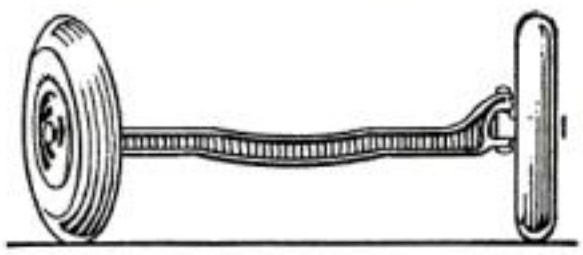
Cuts in tires should be repaired at once

Sand works under the tread, raising blisters

Use This Table When You Inflate Your Straight Side Balloon Tires

Minimum Inflation Pressure (Lbs.)	Maximum Load Carrying Capacities Per Wheel (Car and Passengers)								
	4.40	4.75	4.95	5.25	5.77	6.00	6.20	6.75	7.30
22	500	580		700		850	900		1150
24	550	635		760		925	980	1100	1260
26	600	690	725	820	880	1000	1060	1200	1370
28	650	745	780	880	950	1075	1140	1300	1480
30	700	800	835	940	1020	1150	1220	1400	1590
32	750	855	890	1000	1090	1225	1300	1500	1700
34	800	910	945	1060	1160	1300	1380	1600	1810
36	850		1000	1120	1230	1375	1460	1700	1920
38			1055		1300	1450		1800	
40			1100		1370			1900	
42					1440				

Underscoring denotes maximum desirable load



Wheels that are even slightly out of line rub the tread off the tire in a short time

Cuts such as these are caused by tight chains

Scraping against curbs does this to your tires

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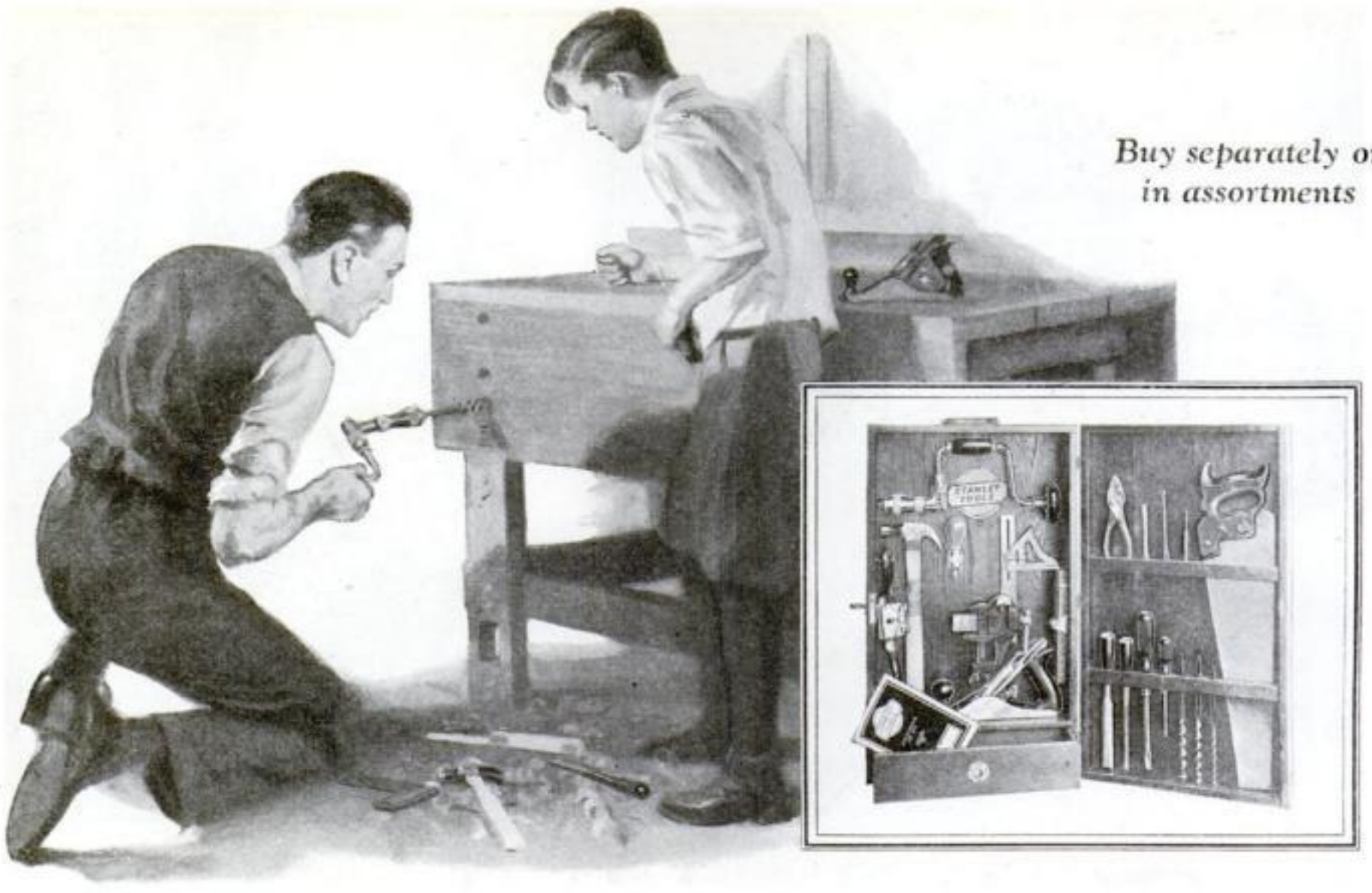

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EVERY tool-user needs a work bench. Here is how to get one at very little cost. Stanley Plan No. SE-72 shows plainly what materials to order, how to prepare them, and how to "carry through" to the finishing touch. Thousands of men have work benches where they do repairing and original construction.

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Your hardware dealer has plan No. SE-72 as well as other Stanley Plans for making useful articles, or he can get them for you. The plans cost only 10c each. Ask him also for small Catalog No. SE-50 which shows the most complete line of woodworking tools on the market. It is free. If he cannot supply you, write to The Stanley Works, New Britain, Conn.

The best tools are the cheapest to use

Ⓢ Ask your hardware dealer

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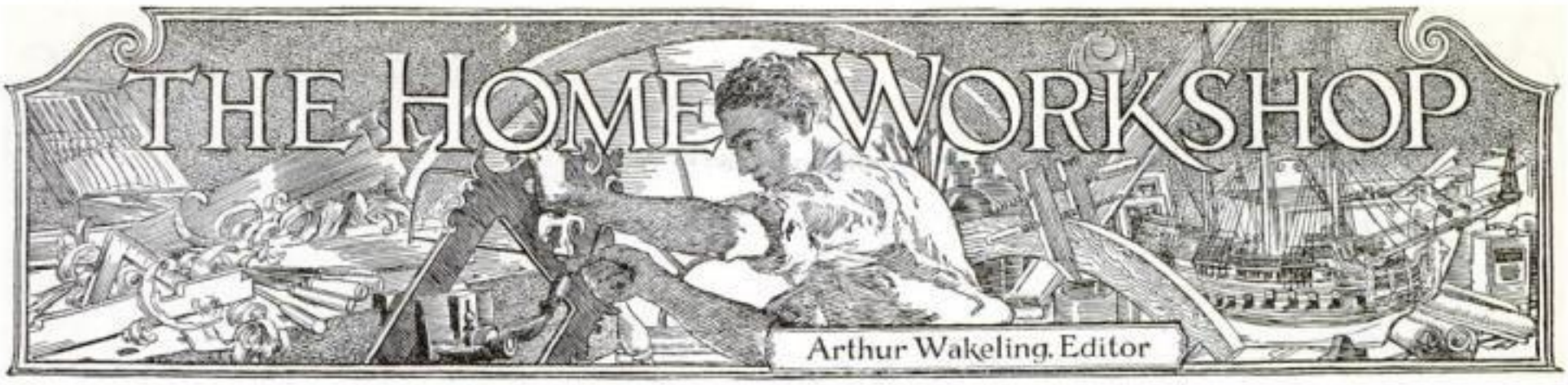
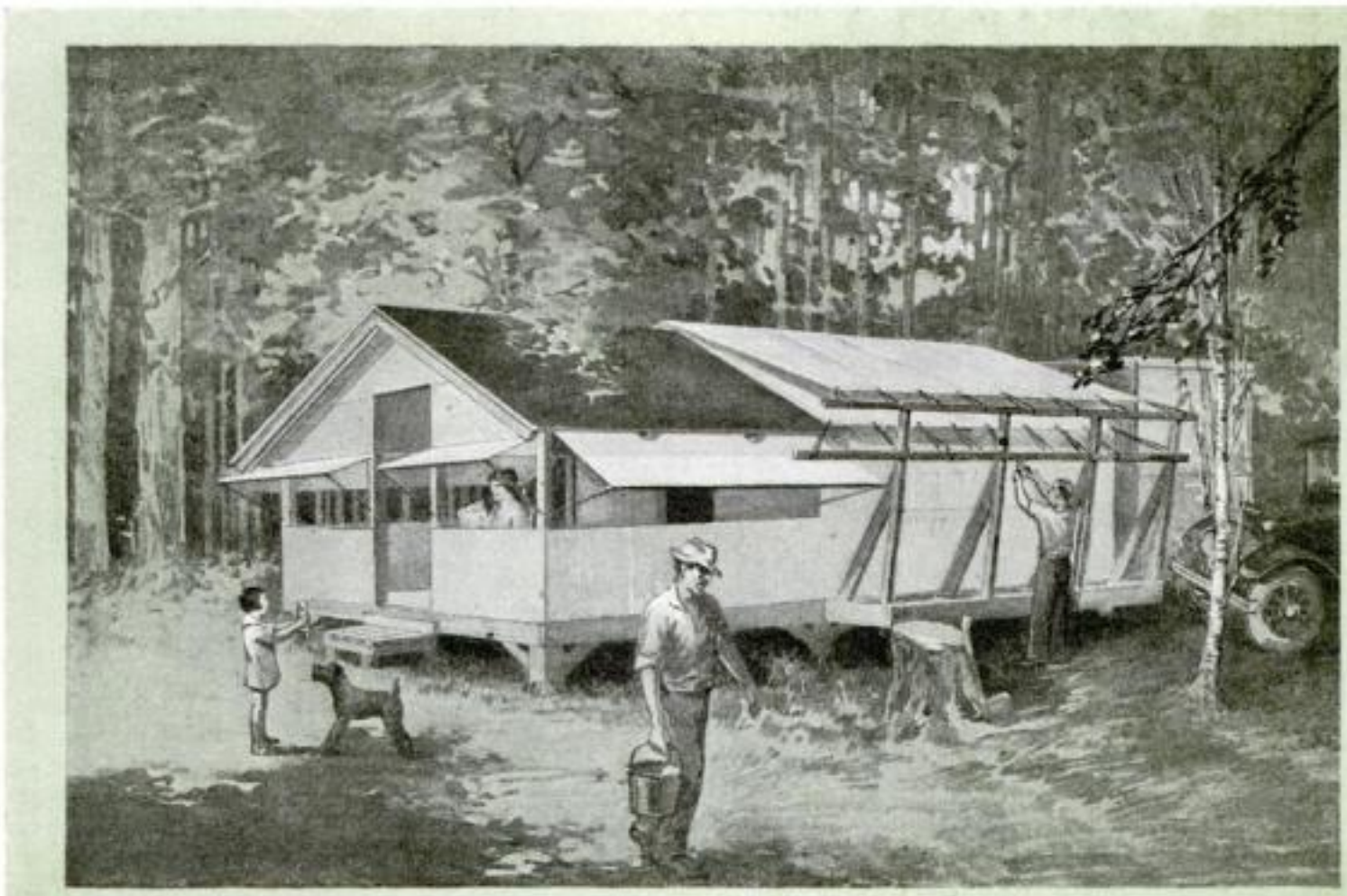




The joys of camping are doubled when a roomy and comfortable canvas house is built in place of an ordinary tent

How to Build a Canvas Camp

Semiportable Summer House Offers Many Comforts—Has Substantial Floor and Frame

By HENRY S. LARABY

CAMPERS who have picked a pleasant location to which they return year after year—and their number becomes larger each season—will find many advantages in constructing a semiportable canvas house of the type illustrated above.

The sides, top and ends can be transported easily by car. The platform and framework are built on the spot and left in place permanently.

One of the strong points of this arrangement is the doing away with the usual pegs for holding the tent top and fly. Every tent camper can remember the stormy nights when all hands have had to turn out in the midst of a violent downpour to drive down slipping tent pegs and adjust the shrunken guy ropes. In place of pegs, there are separate guy rails, each 2 by 2 in. by 15 ft., for the top of the tent and the fly. These are supported by 2 by 4 in. posts, heavily braced.

The method of building the platform and framework is made clear in the drawing at the bottom of page 106.

To set up a camp of this kind, first build the platform and frame and then use a steel tape to take the over-all measurements of each section that is to be covered with canvas. Make sketches and put on the dimensions as you go along. This done, give the woodwork two coats of good outside oil paint.

The canvas sections can be ordered from a tent or awning concern, or one can sew them at home. In either case select a good grade of 12-ounce canvas.

If you decide to make the sections yourself, find a floor or other cleared surface large enough to lay out the largest of them. Measure off a section and drive a 1½-in. nail at each corner. Go 3 in. outside of these dimensions, and drive other nails at the corners. Around the outside nails stretch a cord tightly. Lay the canvas in strips across the section in the proper direction, lapping them 1 in. over each other and pinning at intervals of 2 ft. When you have laid and pinned a strip, cut the canvas off where it passes the cord. Keep laying and pinning the strips until the surface is covered; trim off the ends of the combined strips so that the edges are straight, and then move the cord back to the nails that mark the finished size of the section. Fold the edges of the section over twice, that is, make two 1-in. folds (see page 106). Pin the edge as you go along.

Corner pieces can now be inserted, if desired; lay them under the folded edges and pin in place. Fold up the pinned section when completed and lay out the next.

When all are done, sew them up with the heaviest thread the machine will handle. Windows (Continued on page 106)

A Table *for* Your Bench Lathe

How to Make a Neat and Convenient Stand for Small Machine Tools—Reduces Noise and Vibration

By COLIN L. BLAIR

WHEN the writer purchased a small screw cutting bench lathe, he was confronted with the problem of constructing a satisfactory table arranged for its motor drive.

The usual method of driving small lathes seems to involve the use of an overhead countershaft, and this was not desired. As the outfit was intended to be used in a city apartment, compactness and neat appearance were essential; it had to be quiet in operation and all possible parts inclosed. There was also required storage space for lathe attachments, hand tools and miscellaneous small supplies.

The table shown in the accompanying photographs and drawings was built to meet these conditions, and in several months' use has proved entirely satisfactory.

The framework for the lathe table is easy to assemble, as the joints are drawn together with screws, after which the holes are plugged

The dimensions shown are suitable for a bench lathe taking work 12 in. long between centers, and driven by a one-quarter-horsepower motor of average size. Needless to say, these dimensions must be checked for other installations.

THE table top is of sufficient size to accommodate also a grinding head and a small drill press, which are mounted so as to be easily portable. These are not shown in the photographs.

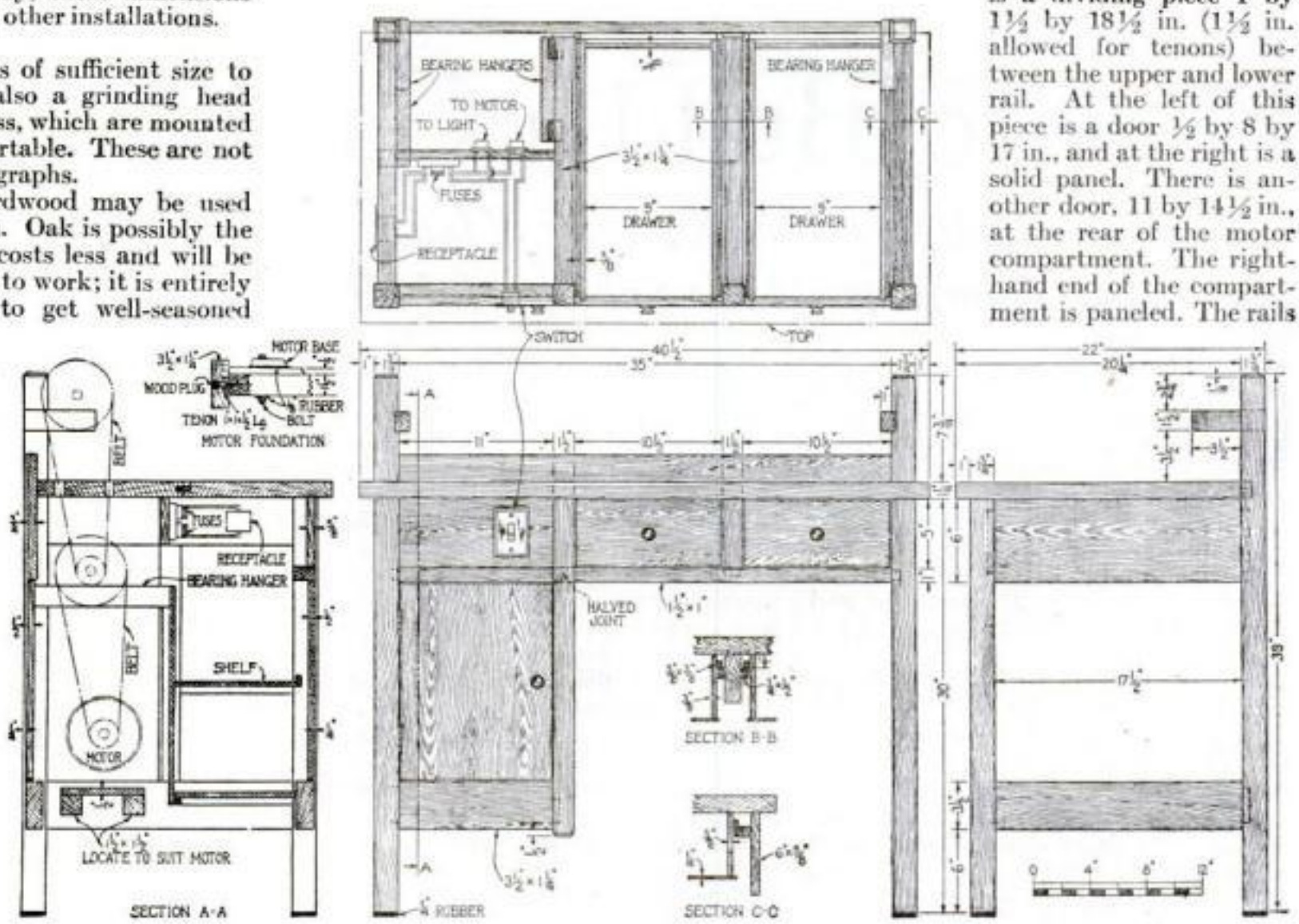
Any suitable hardwood may be used for the construction. Oak is possibly the best. Yellow pine costs less and will be found a little easier to work; it is entirely suitable. Be sure to get well-seasoned lumber. The panels, doors and divisions in the locker space, and the drawers (except the fronts) may be of soft wood, such as white pine. The drawer bottoms are of plywood, ¼ in. thick.

The finish of the table is a matter of taste. The writer stained his with walnut oil stain and applied three coats of varnish. The interior parts were given three coats of shellac.

If the dimensions shown do not meet your requirements, it will be necessary to prepare a dimensioned drawing. Then you may order the material from the mill, finished four sides. Many of the pieces may be combined and ordered in long lengths. Be sure to allow for tenons and squaring up. The top, which is 1¼ in. thick, is shown in two pieces with a spline in the joint.

ALL the principal joints are mortised and tenoned, and fastened with No. 12 wood screws, 1¾ in. long. The screw holes are counterbored to receive the heads of the screws and filled with wood plugs. These joints are easier to make and stronger than concealed fastenings, and in an article of this nature it is immaterial whether or not the plugs show. On a painted job, of course, the plugs would not be seen.

Because the left end of the bench is shown so clearly in a photograph on the opposite page, a sectional view through the locker and motor compartment is used in the drawings below instead of a left-hand elevation. The left end is similar to the right except that the upper rail is 1¼ by 3½ by 18½ in. and there is a dividing piece 1 by 1½ by 18½ in. (1½ in. allowed for tenons) between the upper and lower rail. At the left of this piece is a door ½ by 8 by 17 in., and at the right is a solid panel. There is another door, 11 by 14½ in., at the rear of the motor compartment. The right-hand end of the compartment is paneled. The rails



Working drawings of the table and details of drawer runs and motor foundation. Note the method of wiring, the convenient switch at the front of the bench for controlling the motor, and the provision for connecting a light

may be laid out first and the tenons cut. Be sure all joints are square and each piece is of correct length. Then square up the legs and lay off and cut the mortises. Fit the tenons to their respective mortises and mark each for identification. Locate the fastenings and bore ½-in. holes about ½ in. deep and then bore for the screws.

AFTER this part of the work is finished, it will be well to sandpaper all pieces. Assemble the two ends first, using a good glue in all the joints. Draw up with the screws and then wipe off the excess glue with a wet rag. The front and back rails come next; then the motor compartment and foundation. After the fastenings are all set up, the holes may be plugged with ½-in. wood bungs.

Now fit the hangers for the intermediate shaft bearings and bore for the bearing bolts. Locate the motor and bore holes for the bolts.

Put in the panels and finish up the locker. Then fit a block for the fuse base. Make the drawers and fit the drawer slides. The doors may be fitted and the hinges located, but do not hang them until after finishing.

End view of completed table. The motor, shaft bearings, and lathe rest on ⅛ in. thick rubber to do away with vibration

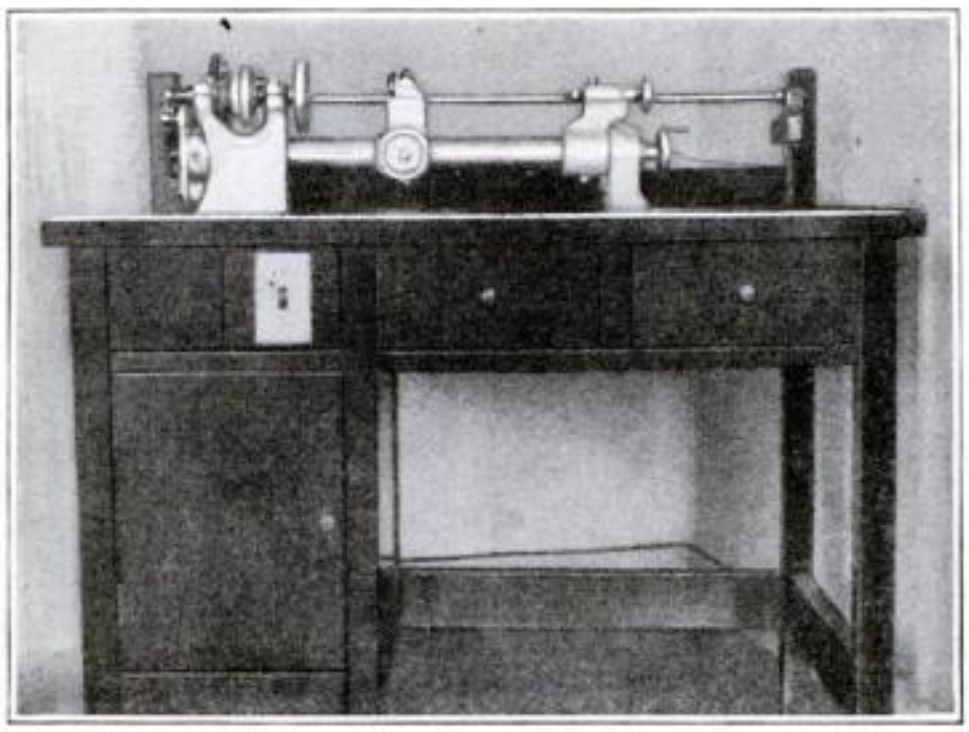
LOCATE the receptacle and switch and fit them in place, also the fuse base and an outlet for the motor and another for the light. The scheme of wiring is shown in one of the drawings. Notice that the switch controls the motor only. Use heavy stranded copper wire well insulated, and solder and tape all joints. The fuses are of ten amperes.

Now you are ready to fit the top, and if this is in one piece, so much the better. Countersink for the screws and drill the holes at a slight angle so as to draw the joints tight when the screws are driven up. Use No. 12 screws 2½ in. long for the top. After planing and sanding the top smooth, fit the hangers for the countershaft bearings.

You can now locate the lathe and bore holes for fastening it. Locate and cut holes in the top for the belt to pass through. Fasten ¼ in. thick rubber on the bottom end of each bench leg, and put ⅛ in. thick rubber under the motor, all bearings and the lathe. Sandpaper smooth and finish as desired; then hang the doors, put on the drawer pulls, and the plates for the receptacle and switch.

The bearings, four in number, are of the conventional pillow block type. In this instance they were made of Babbitt metal. The shafts are of steel, ⅝ in. in diameter.

The speed of the motor is 1750 R.P.M. It is fitted with a grooved 2¼-in. pulley. Two pulleys 5 in. in diameter and one 2 in. in diameter, grooved for a round belt and bored for a ⅝-in. shaft, were bought and arranged as shown. The countershaft speed is 315 R.P.M. A cone pulley having the same diameters as the lathe cone was fitted on the countershaft; this arrangement gives the lathe spindle speeds of 160, 315, and 570 R.P.M. without using the back gears.



Compactness and neatness are achieved by eliminating the usual overhead countershaft. There is room at the right end for a small drill or grinder

A New Way to Hide Wallboard Joints

WHEN fiber wallboard is to be covered with wall paper or with the easily applied plastic paints that are now so popular, the average home worker is puzzled as to the best way to make sure the joints will not crack open in the course of time and disfigure the walls.

If panel strips are used to cover the joints, the shrinkage and expansion of the boards does not matter, but in cases where panel strips are not desirable, the problem of concealing the joints permanently is a difficult one.

What is claimed to be an effective method of treating joints was recently developed in the research department of the manufacturer of a thick type of fiber wallboard. The boards are nailed up in the usual way with 1½-in. galvanized roofing nails having ⅜-in. heads, spaced about 3 in. apart along the edges and 6 in. along intermediate studs.

After being smoothed with coarse sandpaper, the joints are painted with a gesso or putty mixture prepared in the proportions of 5 lbs. bolted whiting, ½ gal. liquid glue, ½ pt. oil paint of any light color, and ½ pt. linseed oil.

A strip of common galvanized insect screening (wire cloth) is applied over the gesso immediately and the paste is worked through and over the mesh with a few strokes of a trowel or painter's scraper. After the gesso has been troweled smoothly off for 2 or 3 in. on each side, the extra thickness is hardly noticeable.

At the corners of the room a 6-in. strip of screening is bent to a right angle and similarly cemented in place. All exposed nailheads are pointed up with the gesso. Then, before the wall is to be papered, a coat of paper hanger's size is applied.

A WALL prepared in this way is not, of course, as smooth as plaster, therefore a heavy and rather rough paper with a bold figure is best.

When plastic paint is to be used on the wall, the strips of screening are fastened on with the paint itself. The paint is applied on top and pressed through the mesh with a painter's scraper. After the nails have been pointed up, the plastic paint may be spread over the entire surface.

How to use plastic paint was told in our January and April, 1927, issues.

Turning Wooden Segments

IN TURNING a wooden article which is composed of two or more segments, it is difficult, if not impossible, to turn the piece first and afterward split it up. That is especially true if an odd number of segments are required and the object must still retain a perfect circular cross section. To overcome this difficulty, the pieces are made up with the correct center angle and then glued together with heavy paper, such as draftsman's detail paper, between each of the segments. After the whole is thoroughly dry, it may be turned and the segments separated. Gluing parts with paper between is, indeed, a trick frequently used by cabinetmakers.

The Latest in Block Puzzles

For all members of the family—A novel, fascinating pastime

Certainly you can solve it! This is at once one of the simplest and most intriguing of block puzzles—indeed, many puzzles in one. And there are more of them—a whole collection of entertaining block puzzles, with solutions—on our Blueprint No. 65 (see list on page 101)

By Arthur L. Smith

PUZZLES of the flat moving block type, which are now so popular, are always of absorbing interest until solved. The one here illustrated should retain its interest longer than the ordinary puzzles because it assumes the form of a fascinating game. After the solution of the problem as first suggested is mastered, the solver can devise other letter or geometrical forms into which the blocks may be moved from their Greek cross position (Fig. 2). Thus it becomes many puzzles in one and an endless source of amusement.

There are 11 blocks: 8 are 1 in. square; 2 are L-shaped with 2-in. arms; one is oblong 1 by 2 in. The two L-shaped blocks, the oblong one, and four of the 1 in. square blocks are preferably darker than the others. The blocks may be painted or stained, or two woods of different colors may be used.

The blocks are placed in a box so that the darker ones form a Greek cross and two of the lighter ones are removed, as in Fig. 2. These two blocks are merely to prevent disarrangement of the others when the puzzle is put away.

THE problem is to move the blocks from the first position to form the letters "PS" (Popular Science) as shown in Fig. 3. The blocks are not to be lifted out or twisted around, and the box is not to be reversed.

Those who find the puzzle easy to solve in this form, will find it more difficult to work it backward, from the PS position to the Greek cross.

A simple method of making a box with a sliding cover for this puzzle is illustrated in Fig. 1. With a sharp knife or a fine saw and an empty cigar box or two, the entire outfit can be made in the course of an hour or so. The paper on the cigar box should be scraped or sandpapered off. The bottom (E) is 5 in. square. On this is glued a frame (D) of ½ in. wide strips, making the inside measure of the box 4 in. square. On this is glued an open-end frame (C) of ¼-in. strips flush with the sides and one end of the box. Above this, also flush with the sides and end, is glued another open-end frame (B) of ½-in. strips. This forms a box with a groove for a sliding cover (A) 4¾ by 4½ in., on the end of which is glued a strip ½ by 4 in. Instead of glue, the nails of the cigar box may be used to fasten the parts together.

The blocks for the puzzle must not fit tightly; they should be made so as to slide easily into the various positions.

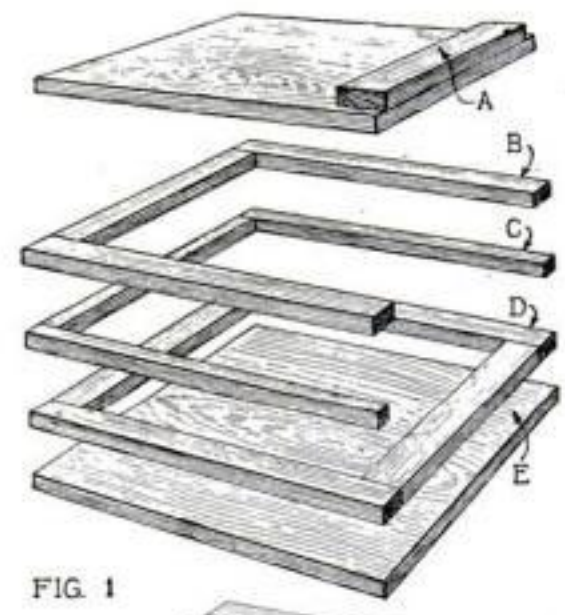
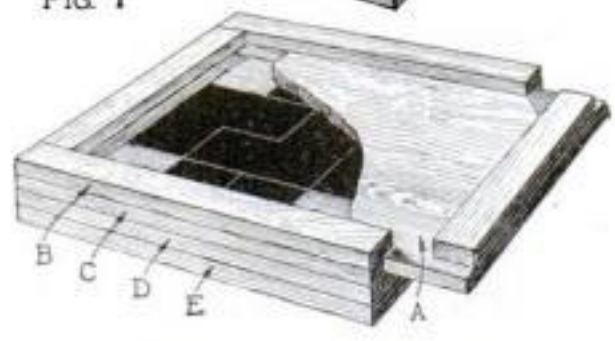


FIG. 1



An especially easy way to make a neat box for the puzzle. Cigar box wood may be used

THE constructor may make a more elaborate and finished box than this if he desires and it will be well worth the effort. The size of the puzzle may be either larger or smaller. If something still more simple is desired, the puzzle may be cut out of cardboard. There should be a bottom with a ½-in. frame of the same cardboard glued on to hold the pieces in position. The darker blocks may be blackened with a pencil.

In devising other forms (such as the SC position shown in Fig. 4) for the second position, some may be found in which it is impossible to move the blocks. The oblong piece is especially obstinate in blocking the way of progress, and for certain figures it may be necessary to saw it into two pieces.

The solution of the PS puzzle will be published in the July issue. It is also to be found on our Blueprint No. 65, now ready, which illustrates a number of other fascinating yet simple block puzzles of various types. **(See page 101.)**

FIG. 2

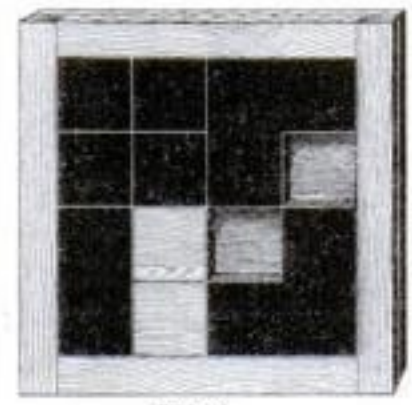


FIG. 3

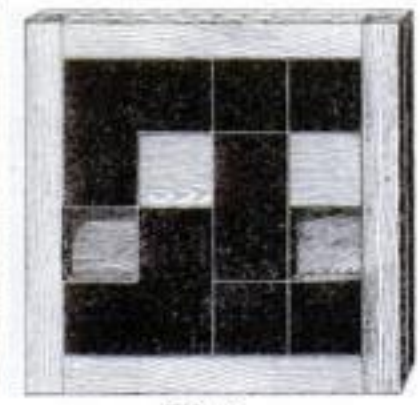


FIG. 4

The blocks are arranged first to form a Greek cross (Fig. 2) and are moved by sliding them from place to place to form a shape similar to the letters PS (Fig. 3) or the letters SC (Fig. 4)

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New Fishing Rods for Old

How to Repair, Rewind and Refinish Split Bamboo

By Robert Page Lincoln

TRULY can it be said that a fishing rod is as good as the care you have given it. Even a cheap machine-made bamboo rod, if kept in good repair, will be equal eventually to a high priced rod that has been neglected.

A rod may be in a good, indifferent or bad condition when you go about repairing it. Often when it is otherwise in satisfactory condition the tips of the rod will have acquired a "set" or downward bend and they must be made straight.

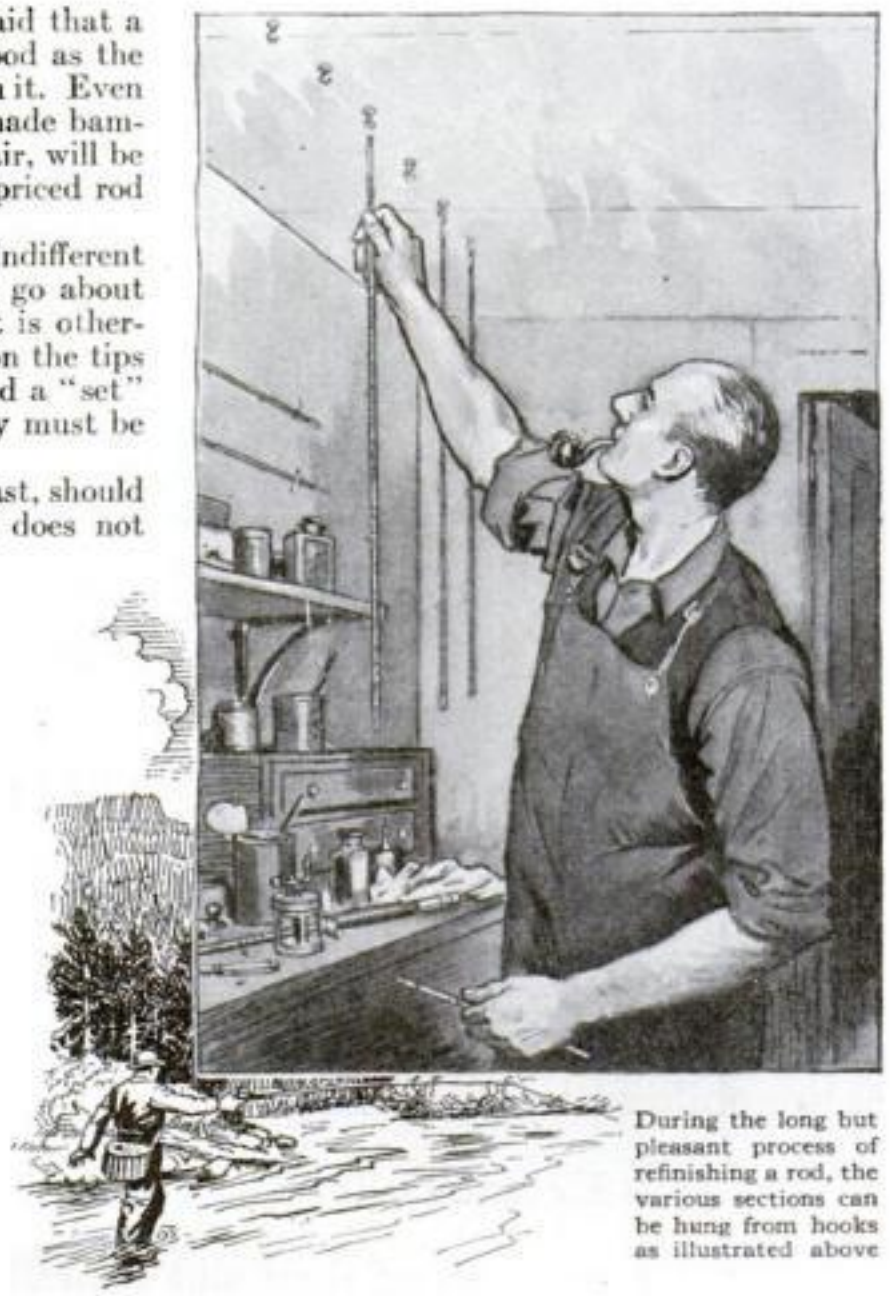
Varnishing, at the very least, should be an annual practice. It does not need more than one worn patch on the rod to invite disaster. Moisture will get in and part the strips of which the rod is made. Then, perhaps in the midst of a struggle with a choice fish, the rod will snap.

If a rod is in good condition save for the varnish, the original windings can be left on. If the windings are worn, it is best to take them off and scrape the rod.

Old rods are apt to have strips unglued up and down from the ferrules for perhaps 4 in. After removing the ferrules, as shown in one of the illustrations on this page, spread the strips and re-glue with a rod-maker's glue, which can be obtained at almost any sporting goods store. Wind the whole length of the newly glued section with fishline and allow to dry for a week or two before scraping.

Let us take, for example, a rod that is in an indifferent condition, with worn patches, frayed windings and a set to the tips. Incidentally, there is no need of your tips becoming set. Even though every rod is supplied with an extra tip, many fishermen will use one tip continually, with the inevitable result that the strain breaks it down. Every fisherman should have two extra tips for his fly rod besides the one on the rod. One tip is used one day, the second the next day, and the remaining tip the third day.

ONE should never leave the jointed rod hanging on nails along the walls of a cabin or cottage, as the tip will bend down. The rod, therefore, should always be taken down at night and carefully wiped dry. In the case of a bamboo bait rod, tie a weight (not too heavy) at the handle, fasten a cord to the tiptop guide, and hang it to a hook in the ceiling. In this manner you can protect the tip piece from taking on any set. Even a bait rod should have at least one extra tip.



During the long but pleasant process of refinishing a rod, the various sections can be hung from hooks as illustrated above

To remove a ferrule, hold it against a hot iron, as indicated above, to soften the cement. This also is a safe way to loosen the uppermost or tiptop guide

Rod windings generally are started on the butt section (right) with several broad bands placed just above the handgrip

No tip can be materially strengthened without removing the windings and the guides. Having done this, take the tip in hand and easily and gradually work the bow out of it by bending it the other way. Pass it occasionally close to some mild source of heat to soften it a trifle; too much heat will be ruinous. The tip then is suspended from the ceiling with a weight tied to the lower end and left for a week or two.

The guides are reinstalled directly opposite their former positions so that their pull will be against the previous set or bow.

Ordinarily the windings in between the guides on a fly-rod tip are narrow—no more than five or six turns of silk thread. In rewinding a tip, strength is gained by increasing the width of these bands to about ten turns. How to make the windings will be explained in detail a little later on.

WHEN the tip is varnished and dry, joint it up with the rod and bend it downward a little at a time by working the tip alone. Then use the full-length play of the rod, with the line threaded through the guides and tied to some stationary object. This is to get the tip limbered up.

If your rod is to be completely rewound and refinished, the old varnish must be removed. A safety razor blade is a good tool for this. Carefully cut through the silk windings and strip them off; then scrape the varnish. Never go deeper than the varnish, since the hard outer skin of the bamboo is its strength and must not be harmed.

Be sure to make a preliminary drawing of each rod joint to show where every guide and winding goes, and make a pin prick on the rod itself at the exact center of each eye.

Care should be observed in removing the ferrules and the tiptop guide, if, indeed, they must be removed. Heat the ferrule over a match flame or, better, heat an iron red-hot and turn the ferrule around on the iron. The flame of a match is especially likely to injure the bamboo close to the sleeve of the tiptop guide, and the hot iron method is safer.

To cement the ferrule on again, heat the wood over which the ferrule goes with a match, or over a fire, and heat the ferrule also. Melt the ferrule cement, which comes in stick form, on to the wood with a match and slip the heated ferrule home with a quarter twist.

To return to the varnishing operations, go over the scraped rod with the finest grained sandpaper to be had. (Continued on page 92)

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TRY this ¼-inch Heavy Duty electric drill on those long, hard jobs you've always tackled with a hand or breast drill. You'll open your eyes with sheer delight to see it bite its way through metal. And wood? Well, oak and hickory are a joke to it.

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Every part quickly accessible. Can be taken apart in five minutes. Standard screws used in assembly.

C-l-e-a-n. Tightly sealed lubrication keeps commutator, armature and field from becoming oil-soaked and foul.

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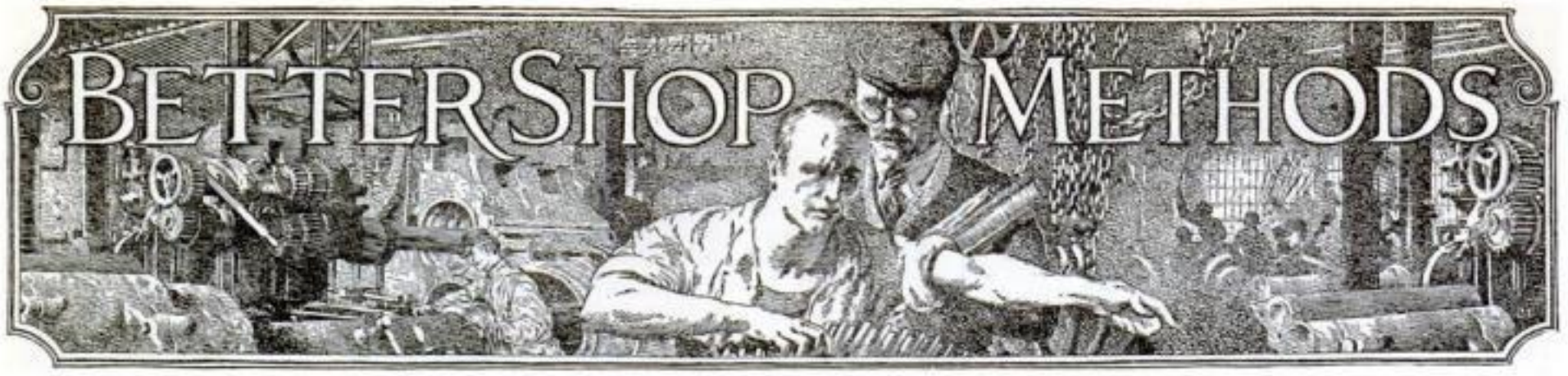
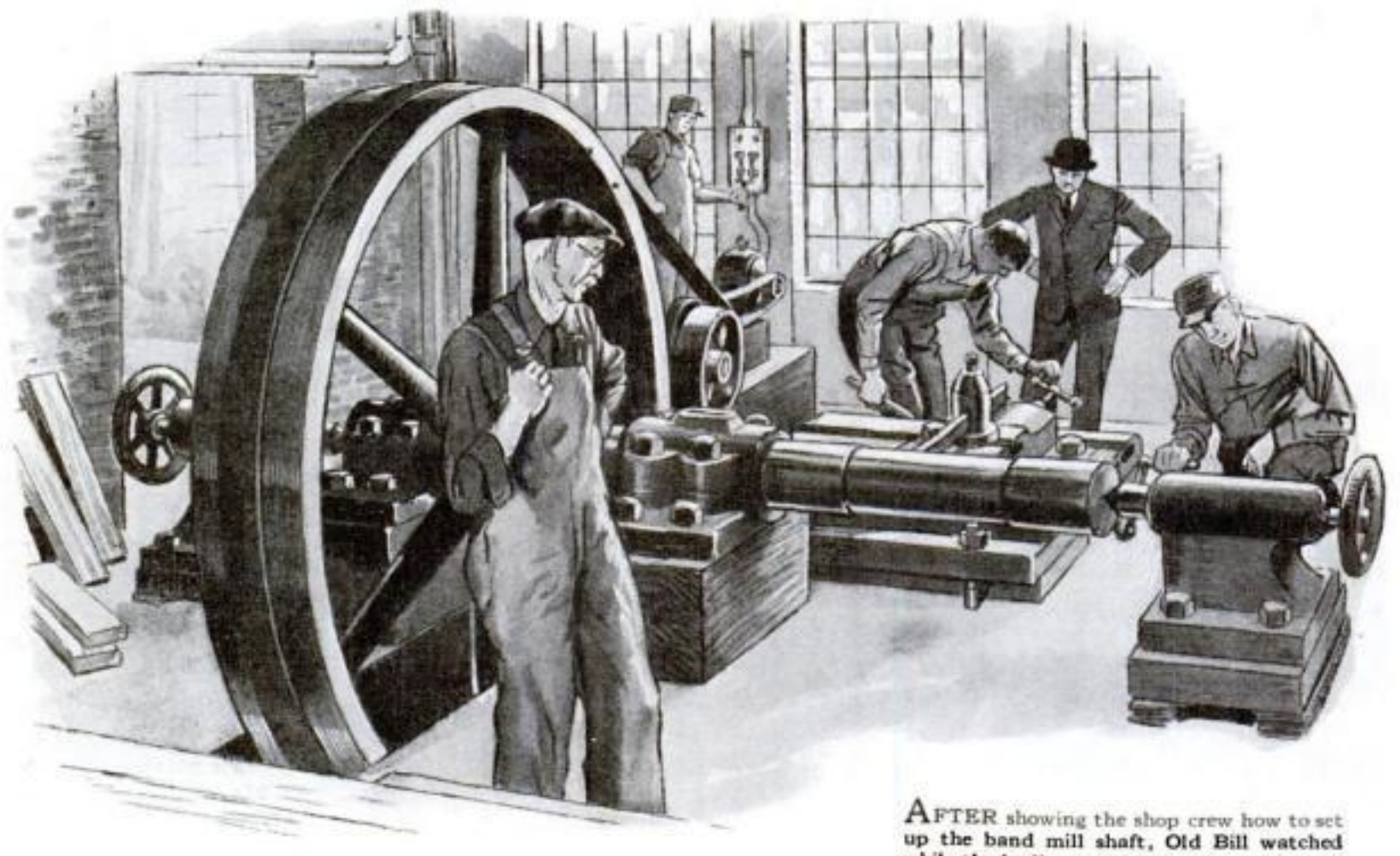


A Job Too Big for a Lathe

Yet Old Bill Had to Turn the Mill Shaft Quickly— How He Did It May Help You Solve Similar Problems

By JAMES ELLIS



AFTER showing the shop crew how to set up the band mill shaft, Old Bill watched while the badly scored journals were turned

OLD BILL went to meet the office man, who was hurrying through the shop toward him.

"What now?" he asked.

"The Binklers want you to come out to their saw mill as soon as you can. The shaft on the band mill is scored badly because it ran hot, and they can't get the wheel off so they can send the shaft to the shop."

Old Bill knew the concern. A large establishment with a shop of its own, it sent only the more difficult jobs to him. He knew that the problem must be a real one if it stumped the Binklers' capable shop crew, so he prepared to drive to the plant, which was ten miles out of town.

He had plenty of opportunity to muse about things in general as he drove, for there was little traffic on the road, and the spring air made motoring pleasant. All too soon he was at the mill.

"This wheel is supposed to come off the shaft easily," the mill foreman explained, "but we have tried it with a twenty-five-ton jack, and can't do a thing with it. We wanted to know if you could arrange to turn the shaft without taking off the wheel."

Old Bill studied the wheel. Eight feet in diameter, and about four tons! Not a lathe within 200 miles that would swing it! Not even the wheel lathe in the railroad shop, for the shaft was too long.

Old Bill pondered these facts, and then started for an apparently aimless walk. The mill foreman followed and Old Bill answered categorically the questions put to him. "Yes" or "no" was the only response he gave, for he was thinking. Finally he said: "We can turn the shaft here as well as any other place."

The mill foreman and the shop's machinist, Edward Lamons, looked at him blankly.

"What! Why, we have no lathe that will take anything nearly as large as that!" the mill foreman exclaimed, somewhat heatedly. "The largest lathe we have is only twenty-eight inches, and the other is only twenty!"

The foreman's *(Continued on page 111)*

MANY time-saving shop ideas are contained in the continuation of the Better Shop Methods Department, to be found on pages 109 to 118.

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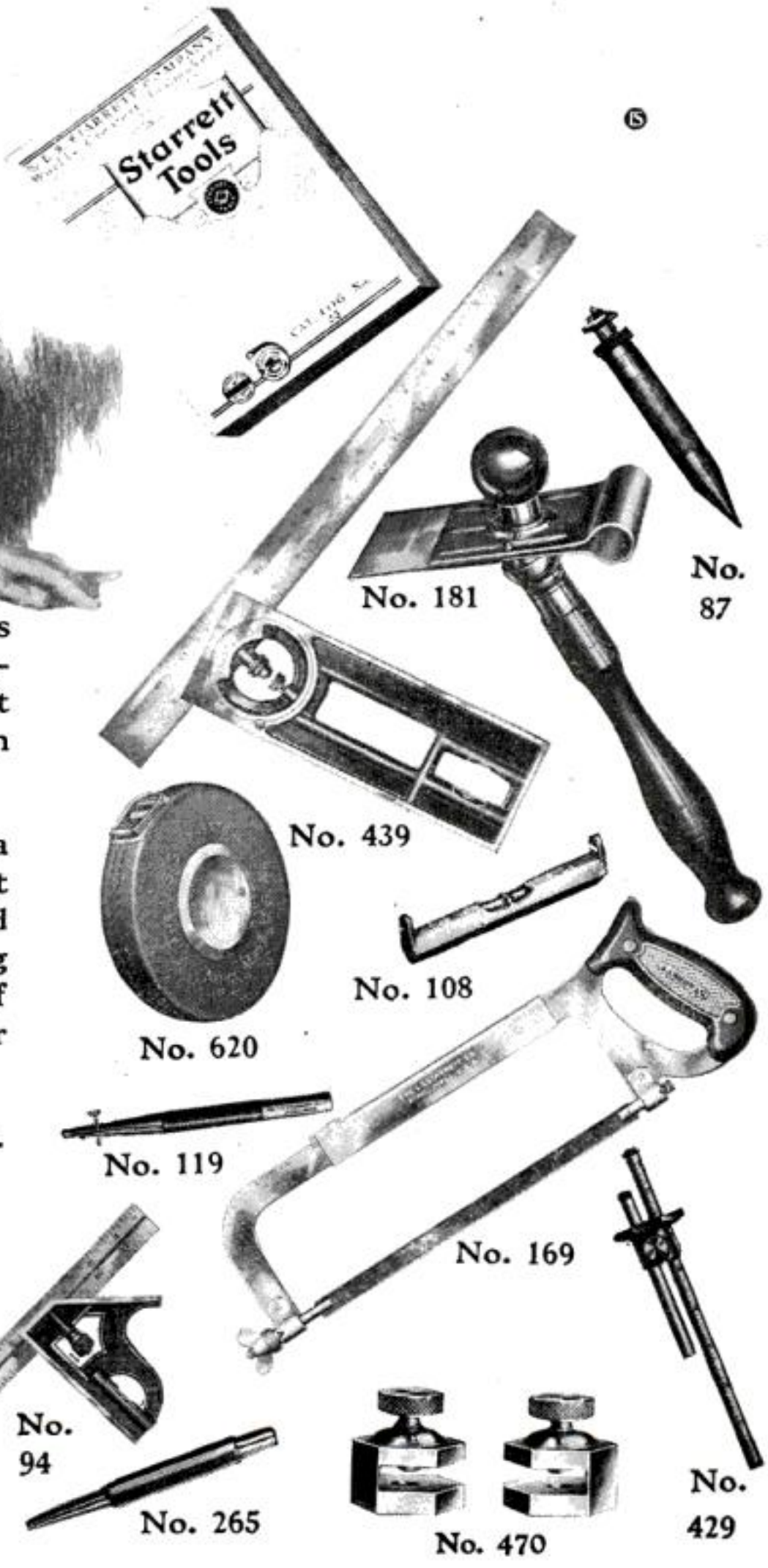

Use Starrett Tools

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How *to* Replace *an* Old Electric Light Bracket *with a* Sconce

By GEORGE A. WILLOUGHBY

ARTISTIC electric wall sconces can easily be installed in place of old-fashioned brackets which have become defective, shabby or otherwise unsuitable.

Fig. 1. It is a simple matter to substitute an artistic sconce for an old-fashioned bracket

The first step before starting this or any other type of repair or replacement work is to open the main house switch. Then, to remove the old bracket (Fig. 3), loosen the screw holding the canopy, and pull the canopy from the wall to expose the fixture support and the connections. Cut the fixture wires and unscrew the bracket, or, if necessary, first remove the screws holding the crow-foot or fixture stud and cut the fixture wires after the fixture has been pulled from the wall.

The next step is to provide a good support for the new sconce. The simplest way is to install the special stud furnished with the sconce by attaching it to the wall with three wood screws as in Fig. 2, but this is not necessarily the best. In some old installations where the crow-foot is attached to lath, it is a great improvement to substitute a suitable outlet box (Fig. 4) such as now is used in good installations. It provides a fireproof inclosure for the wires and a more rigid support for the fixture.

Select a shallow box, which, when attached to the lath, will be flush with the plaster or extend slightly in front of it. It must be provided with knock-outs for loom so the loom-covered wires can be brought into the box and clamped in place, as illustrated. The fixture stud may be attached to the box with stove bolts or it may be screwed to the lath through openings in the box. Additional screw holes in the box make a rigid installation possible. Hold the box on the wall where it is to be installed and carefully cut around it with a small, sharp screw driver or knife so the plaster can be removed from the space within the circle. After the plaster has been removed, bring the loom-covered wires into the box and attach the box securely.

The stud furnished with the sconce is threaded to fit a fixture stud, or it may be used in place of a fixture stud.

After the fixture support has been provided, remove covering from the ends and clean the wires for making the connections. The joints should be made as illustrated in Fig. 4 and soldered and served with rubber tape (or splicing compound), and a serving of friction tape, wound in the opposite direction. Then attach the sconce (Fig. 1).

Fig. 3. The first step in removing the old fixture is to loosen the canopy

Fig. 2. Screwing to the wall the special stud furnished with the new sconce

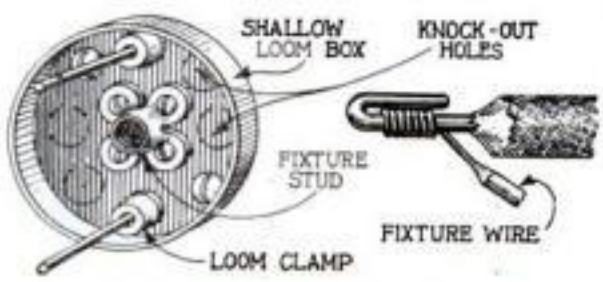

Fig. 4. An excellent type of outlet box for this work; method of connecting wires

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THE WORLD'S LARGEST BUILDERS OF SHIP MODELS will supply you with parts to build a MELODY SHIP. You may choose either the Santa Maria or the Mayflower Model. The parts for the Ship Models are made of wood. This is not a cheap cardboard imitation, but a real Ship Model. Putting it together is as simple as A B C. The instructions read like this: "Put No 49 on top of No. 48, and tap lightly with a small hammer," etc. A school boy can put one together in a few hours.

The Loudspeaker Unit is of the Electro-Magnet type. Power amplification is not needed to force the low tones through. They come through with ease and do not interfere with the higher notes, giving you faithful reproduction at all frequencies. The Unit is placed on the main mast, which is firmly seated two inches deep in the three-and-one-half pound hull, making it impossible for countervibration to affect the reproduction of the MELODY SAIL. The driving pin is attached to our specially prepared, super-vibrating MELODY SAIL. It does not change the appearance of the Ship Model. Instructions for installing come with each MELODY SHIP.

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The unassembled parts for either the Santa Maria or Mayflower Model, without the MELODY SAIL attachment, can be had for **$4.98** plus postage. Full detailed diagram and instruction sheet showing and explaining every operation for completing the Model supplied with each.

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SHIP MODEL only	**4.98**
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A Circular Saw Attachment for Your Tool Grinder

By Edward Thatcher

FOR the home shop not fitted with a power driven saw, the hand operated circular saw illustrated will be found most handy. The whole cost of the one shown was $3.86, which included the grinder and two circular saws, one for ripping and the other for crosscutting. If you have a grinder, the only expense will be for the saws. The remainder of the materials usually can be found about the shop.

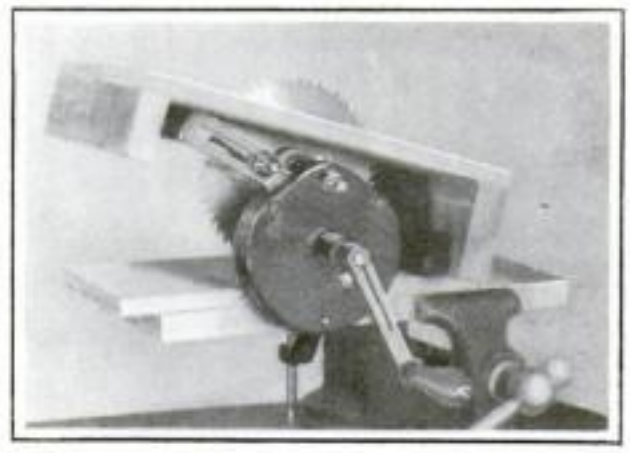


Fig. 1. Hand driven saw for cutting and grooving ship model parts and small work

While this little saw table is not for handling the heavier sort of work cut with a power saw, it is most useful for the smaller pieces of wood such as are used by ship model builders, toy makers and those interested in the lighter form of construction (Fig. 4).

It is rather difficult to rip narrow strips of thin wood with any degree of accuracy by hand, but with this machine any wood up to ½ in. thick can be cut into uniform strips; grooves may be made with and across the grain; and soft wood up to 1 in. thick may be crosscut, if the saw is well sharpened and set.

By making a special washer (Fig. 3) to cause the saw to wabble, it is possible to cut grooves ¼ in. wide. Indeed, if you have no other device for grooving, you will find it worth while to make the attachment for this operation alone. It will allow all sorts of small picture frame moldings and the like to be made.

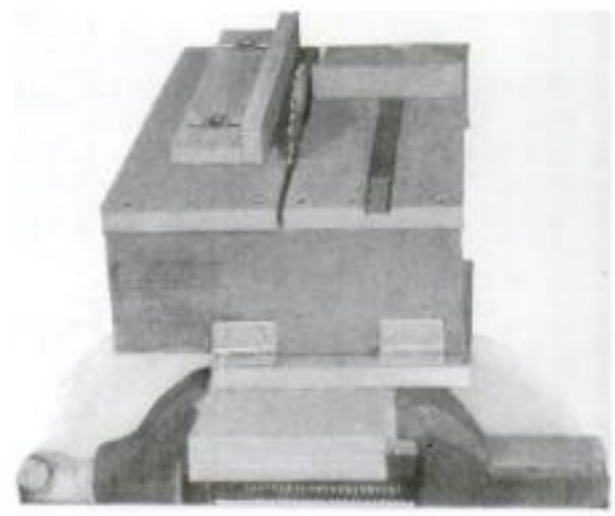


Fig. 2. The saw from the rear, showing crosscut guide and adjustable ripping fence

In this instance the tool grinder had a 6-in. wheel, so 6-in. saws were ordered, with holes to fit the grinder spindle.

The saw table must correspond to the size of the grinder. In this case the baseboard was cut ½ by 6 by 12 in. and under it was screwed a piece ⅞ by 3½ by 15 in., for the vise jaws to grip.

The table, which may be made of pine, whitewood or maple, is ½ by 8¼ by 12 in. It is really in two pieces, divided by the saw, as shown in Fig. 2. One piece is provided with a shallow groove for the tongue of the crosscut guide, which slides back and forth in it. This guide is a block of wood screwed to a length of band iron ½ in. wide and 5 in. long. Several screw holes may be provided in the guide so that it may be set for mitering or at any angles you wish. The slot may be lubricated by rubbing a large lead pencil back and forth in it.

The ripping fence is attached to the other side of the table by means of wood screws or stove bolts. Slots are provided so that it may be set at various distances from the saw. Both pieces of which the guide is made are ½ in. thick; one is 1¾ by 9 in. and the other, 1 by 9 in.

The end of the table is screwed to a block 1 by 3 by 8¼ in., or whatever the width of the table happens to be. This block is hinged to the base, as in Fig. 2.

Mount the grinder with the saw in place before hinging (Continued on page 87)

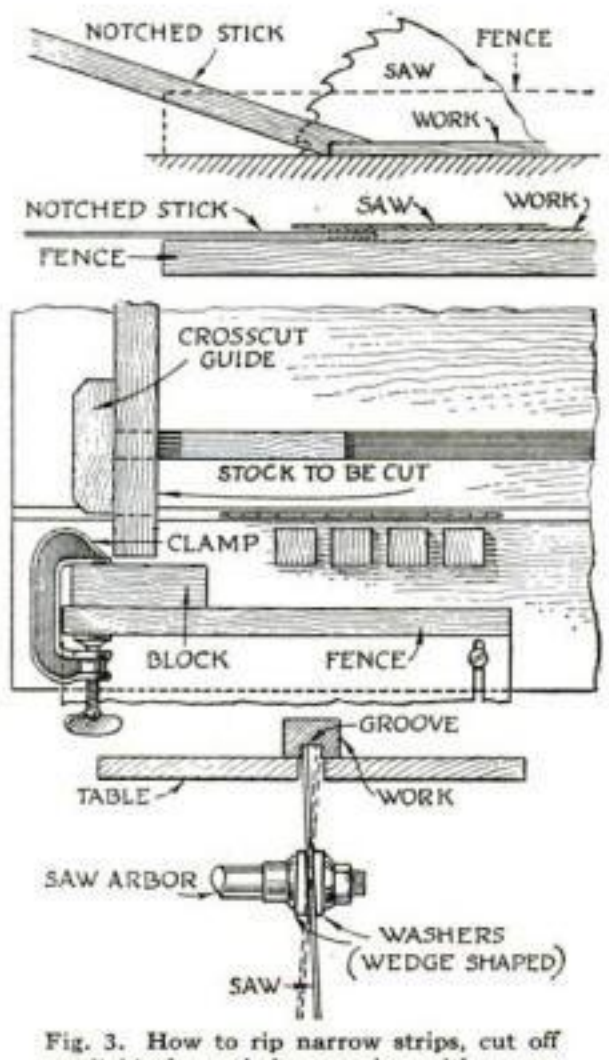


Fig. 3. How to rip narrow strips, cut off small blocks, and do grooving with a saw

Circular Saw Attachment

(Continued from page 86)

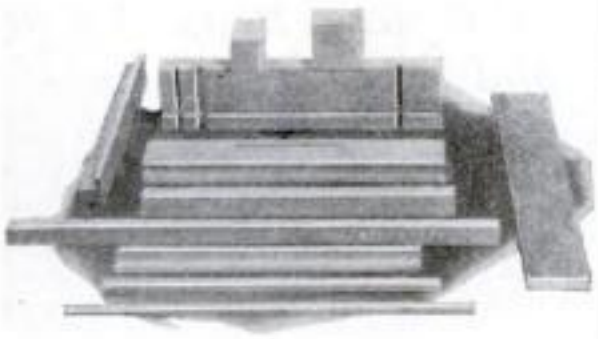


Fig. 4. This is the sort of work the saw does. Mr. Thatcher, who is a distinguished craftsman, devised the machine in an emergency when he was temporarily deprived of power in his own very completely equipped shop. He found it so useful that he keeps it handy for small model-making and similar jobs

the table and make sure that the top is square or at right angles to the saw blade, and also that the slot for the saw runs parallel to the blade so that all work will be true and square. The table may be tilted and held at any desired angle by the grinder tool rest, as in Fig. 1. That allows the depth of the saw cut to be varied for grooving.

The slot for the crosscut guide may be made on the saw itself, provided an extra piece of wood is used temporarily on the left side of the table. Two cuts should be made and the wood removed with a chisel.

The saw should be turned up to full speed before wood is fed against it and the same precautions should be used as with any circular saw. A notched stick should be used to feed narrow strips between the saw and the ripping guide (Fig. 3). When a number of short lengths of wood are to be cut off, a block should be clamped to the ripping guide and the work held at right angles to the saw with the crosscut guide, as shown in Fig. 3. This will prevent the pieces from becoming jammed between the saw and the fence, as would be apt to happen if the block were not used.

The wabble saw (Fig. 3) merely requires a wooden or Babbitt metal washer thick enough to be cut diagonally into two parts, so as to throw the saw out of line sufficiently to cut the width of the required groove.

A saw table of this kind may be adapted easily to a lathe. In that case the saw is held on a mandrel and the baseboard of the saw table is clamped to the lathe bed, suitable grooves or cleats being provided to hold it in line.

How to Hold a Spokeshave Blade for Sharpening

WHEN sharpening a spokeshave blade, there is some danger of grinding one's fingers unless some sort of a holder is used. A safe and easy way to hold the blade is with a small hand screw. —H. A. MELROSE.

Spokeshave blade held safely for grinding

How to *Refinish* Your Floors

Shellac and Wax—Clear and Dark Varnishes—Brushing Lacquer

By Ralph G. Waring

Dark varnish stain renews an old floor

HOW shall I finish the floors of my home? Which is better, shellac or varnish? Are brushing lacquers serviceable for floors?

These and similar questions are asked endlessly in every paint store. Let us, therefore, review the various finishes. It is taken for granted, of course, that the floor to be finished has already been sandpapered and filled properly, as outlined in last month's article.

The first finish to consider is shellac and wax. This makes a beautiful finish when properly cared for, but does require constant looking after to keep it in first-class condition.

The shellac sold in paint stores should be reduced with three pints of alcohol to a quart of stock shellac. Orange shellac is preferred by some to white. It should be applied with an extra long black China bristle brush about 3 or 4 in. wide.

Considerable care and skill are necessary in using shellac. Apply it quickly and evenly with a well filled brush to not more than three or four boards at a time, starting in a far corner of the room. The strokes should be quick, even, and as few as possible, in order to avoid laps.

All work should progress from the raw boards to the finished portions in order that the stroke may be lifted up quickly at the end of the left-to-right movement. In no case should the new stroke be started on the end of the portion last finished, or heavy laps will be sure to show. By taking care and studying the results of your brushwork, your skill necessarily will increase. The most common fault is that of over-brushing.

Do not apply more than two coats of shellac in an eight-hour day. The final coat should dry overnight so that waxing can be started the next morning.

Either the liquid or solid floor waxes can be applied and on dark floors a dark or black wax only should be used or a gray cast is apt to appear. To color floor wax add one part dry pigment colors to four or five parts wax by volume. Powdered raw sienna, burnt umber and rose lake are suitable colors and these can be mixed with wax to match any dark floor.

A large ball of wax can be inclosed in cloth and rubbed on the floor. Cover the entire floor before beginning to polish. This may be done either with a weighted brush made for this work or with an electric polishing brush, rented from the local hardware store. This last is, of course, a great labor saver; it produces a fine polish and is more than worth the rental charge.

On new work it will pay to apply two coats of wax, allowing about an hour between coats to be sure the first has hardened well.

I have found that a final rub either by hand or by facing the weighted brush with a piece of good body Brussels carpet will give an extra brilliant finish.

Worn spots near the doors and on stair treads should be washed with gasoline, dried and rewaxed frequently. All exposed portions of the floor should be waxed once a month, and occasionally polished with a weighted brush.

The next type is the varnished floor. Here again we have a choice between the clear varnish, which will not affect the color of our floor as left by the filler; the dark oak varnish stain, which is pure brown; the walnut stain, which is one part red and two parts brown; and the dark mahogany varnish stain, which is equal parts of red and brown with the red tone dominant. These transparent color varnishes aid materially in producing an even tone. They also have a material darkening effect on the whole floor. In general the varnish stain coat should be followed by a coat of clear varnish.

ALTHOUGH it is often claimed that varnish will dry hard in forty-eight hours, it is necessary that as much more time be given between coats as possible. Three days is not too much and at least a week should pass before furniture and rugs are placed.

Of late years it has been possible to obtain a dull floor varnish of light color; this gives a finish without high gloss and similar in effect to a gloss varnish which has been laboriously rubbed dull with felt, pumice stone and crude oil.

Contrasted with these finishes, we have the remarkable new finish called brushing lacquer. Here at last is a tough, durable finish that can be applied and used in a few hours rather than days or even weeks. It does have its limitations, however, and is far from being "foolproof." On a newly sanded floor, (Continued on page 89)

How to Refinish Floors

(Continued from page 88)

properly filled and hardened for forty-eight hours, clear brushing lacquer, of a quality guaranteed by the manufacturer for this use, can be applied directly to the filler with a black China bristle brush with extra long bristles, made especially for lacquers. If this type cannot be obtained, a fitch or ox-hair bristle brush is to be preferred; a fairly soft but full chisel brush is necessary.

The manufacturers claim that this kind of lacquer will dry in thirty minutes, but after testing eleven brands, I have found none that was not somewhat sticky or tacky at the end of an hour. A floor is always so much colder than the usual test panel used in the laboratory, that both the "initial set" and hardening are much retarded. For this reason I seriously object to the application of more than three coats of lacquer in an eight-hour day. The last coat should dry overnight with heat in the room.

TO MANY the odor of brushing lacquer will be rather trying, but with free ventilation the odor will be dispersed rapidly and soon forgotten. One caution should be observed and that is to avoid lacquering a floor in a room containing a stove with a fire. I have held a lighted match 1 in. from a panel lacquered five minutes previously without having a flash, but the solvent and air do form an explosive mixture, and because of this reasonable care should be exercised.

My experience has been that floors cleaned with varnish remover cannot be lacquered successfully. On a test floor I treated one half with caustic and the other half with varnish remover. When lacquered, the caustic-treated section hardened on time—forty-five minutes; the other, cleaned with varnish remover, took twelve days to harden. I found upon technical examination that enough paraffin wax remained on the floor and in the joints, in spite of careful cleaning with denatured alcohol, to cause trouble with lacquer. Minute traces of grease or wax will so slow up the action of lacquer that it is no better than varnish for speed. As a matter of fact, varnish applied to a dried floor previously cleaned with remover will dry to a satisfactory finish on time.

WHERE the painted floor effect is desired, especially in kitchens, these lacquer enamels—or pigmented lacquers, more correctly speaking—offer a genuine relief to the housewife whose family cares prevent the use of varnish or floor enamels because of the "tying up" of the kitchen. If the floor is well mopped with washing soda and water at seven in the evening and dried till nine, it can be given a coat of gray floor lacquer, for instance, in an hour, allowed to dry overnight and safely used the next morning.

Brushes used in lacquers must be thoroughly cleaned in lacquer thinner or they will become rock hard.

Wax should not be used on lacquered floors, since no method I have yet tried will remove it so thoroughly as to allow the floor to be relacquered without slow drying.

Neat Bookcase Joints

How to fasten furniture cases together without using nails or screws— Dovetail-dado construction

By Emanuel E. Ericson, *Noted Manual Training Authority*

1 Square two lines across the vertical members of case where each shelf is to come, and a third one ¼ in. above the lower line in each instance. See 2

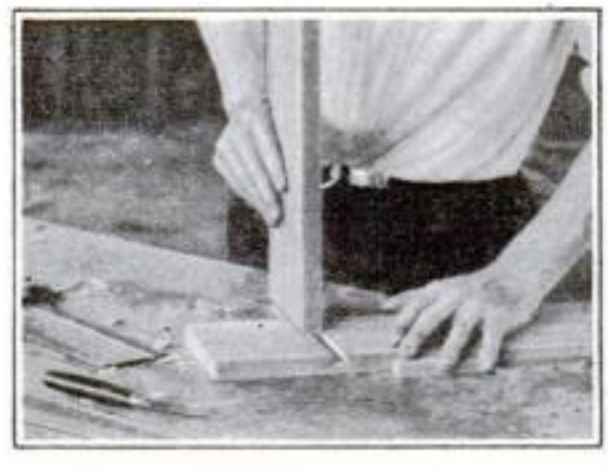
2 (Right) Gage on edge for depth of groove (see 7); mark tail or tenon on shelf to correspond; mark angles on both members with a bevel square

3 (Left) Saw vertically to the gage line where top edge of shelf is to come. This edge of the groove is to remain square. A V-cut may be made with a chisel to facilitate starting the saw, if desired

4 Make the angular cut for the groove by holding the back saw at the proper slant

5 Cut out the groove with a chisel that is narrow enough not to mar the edges

6 Saw and chisel the tenon or tail on the shelf or cross member. Be careful not to split off the sharp edge. Some mechanics prefer to use a wide chisel and make the cut from the end of the wood. Work closely to the lines



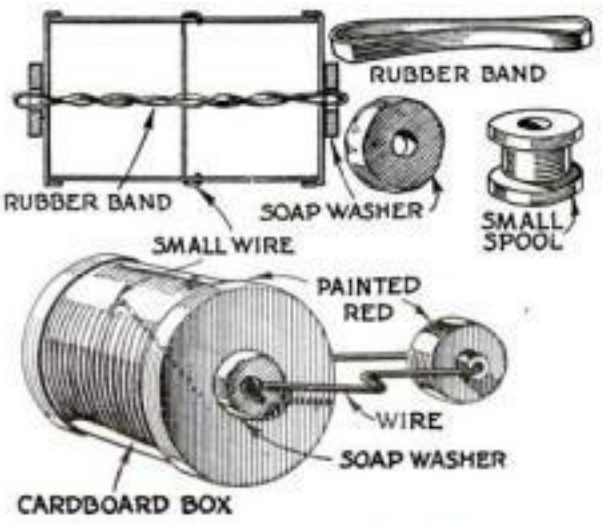
7 One should be able to slide the tail or tenon into the groove with the pressure of the hands alone. Glue may be used in the final assembly unless the piece of furniture is to be made collapsible for ease in shipment

Rubber Band Tractor Is Amusing Toy

By F. Clarke Hughes

THIS month's "comicull" is a rubber band tractor, which will please the children because it will run.

The materials needed are a cardboard box 2½ in. or less in diameter, a large rubber band, a stiff wire, two disks of soap or paraffin, and a small spool or other round object for the rear roller.



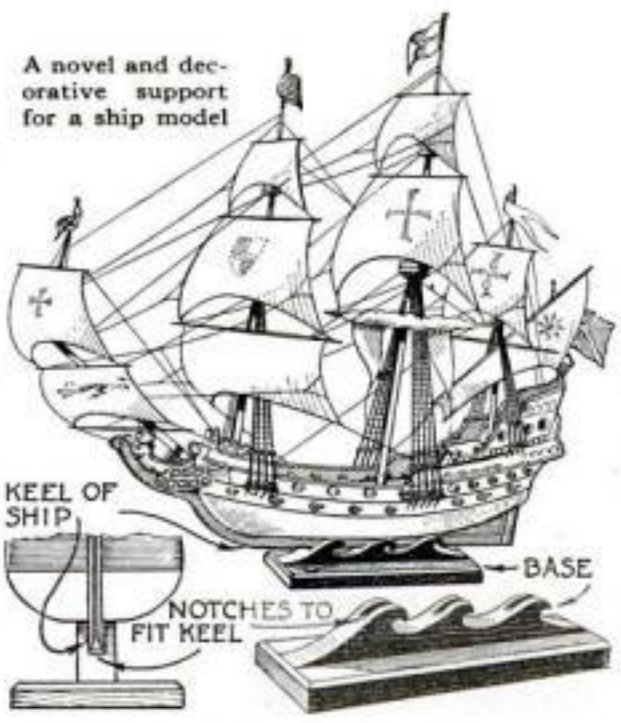
How the tractor is assembled. Two washers made of soap or paraffin regulate its speed

These are assembled as shown. Note that a thin wire, placed crosswise through the box, passes between the rubber strands.

The toy will be more attractive when painted in very bright colors.

To wind up the motor, merely turn the cardboard box a few times. With a powerful rubber band, the tractor should run 15 or 20 ft., if wound to full strength.

Builds Wavelike Stand for Galleon Model



A novel and decorative support for a ship model

AFTER building a Spanish galleon from plans published in Popular Science Monthly, Floyd E. Freeman of Philadelphia designed the stand illustrated, which differs considerably from those ordinarily used for decorative models. It has the advantage that it does not interrupt the flowing, graceful lines of the hull. The model itself is the ship shown on our Blueprints Nos. 46 and 47 (see page 101).

New Fishing Rods for Old

(Continued from page 80)

Get No. 6-0, if you can. Then rub the joints with tissue paper and clean with a few drops of gasoline on a silk cloth.

You can grade your new winding silk with the original silk threads taken from the rod. Keep specimens from the butt section, the middle section, and the tip. Any sporting goods store will furnish thread in spools to match these samples.

Some amateurs choose loud and flashy colors, but it is far better to use only two colors in more or less light shades. Green and yellow are excellent.

Many fly rods are still fitted with the so-called ring-and-keeper guides. These I should be inclined to replace at this convenient opportunity with snake guides.

All rod windings terminate with what is known as the "invisible ending." In the diagrams on page 93 are shown two methods of accomplishing this. The needle method is by far the better when making windings of five or six turns, such as on the tip section. When the end of the thread has been clipped close, work around the band in one direction with your thumb and forefinger so as to smooth the threads.

When you arrive at the point where the first guide is to be installed, tie down each shoulder temporarily with a couple turns of silk thread; knot and clip off the ends. Then wind over one of the shoulders until it is locked tight; remove the temporary thread and finish the winding. Fasten the other shoulder similarly (see the diagram on page 93).

When rod sections are varnished, they are hung up by means of plugs and screweyes

WHEN all the windings have been made, pass them swiftly over a flame just close enough to burn off the silk fuzz.

If you should apply varnish directly to the silk bands, their colors would change, so apply a coat of thin, high grade white shellac to the windings with a small artist's camel's-hair brush. The shellac can be purchased at sporting goods stores; if ordinary white shellac obtained from a paint store is to be used, be sure to thin it liberally with alcohol. Go around the bands, not up and down. Wipe off the shellac immediately; just enough is needed to wet the silk threads through. Allow the windings to dry from four to ten hours.

The question as to whether the initial coat over the bamboo should be shellac or varnish depends upon the condition of the rod. If it is new or comparatively new and from good to fair in condition, it does not need a first coat of shellac. If the rod is old, my experience has been that it is wise to shellac it and hang the joints up to dry for not less than a week.

Generally, however, the first coat on the bamboo will be varnish. Many varieties of spar varnishes and coach varnishes are used. A clear brushing lacquer of high quality, if guaranteed by the manufacturer for use outdoors and on sporting equipment, is probably as durable a finish as one could wish; at any rate, it has the great advantage of drying quickly.

The varnish used must not be too thick and heavy, a condition met with especially when the weather is cold. Many prefer to apply four or five coats of thin, easy flowing varnish to two or three coats of heavy varnish. The varnish should not be cold; my practice is to place the receptacle holding it in warm water. Heavy varnish may be thinned with a little genuine spirits of turpentine.

CUT wooden plugs to fit into the open ferrules of the butt and middle sections, turn a small screw eye into each, and hang up as shown on page 80.

Use a brush ¾ or 1 in. wide, preferably flat, and with bristles not too soft. The entire secret of varnishing a rod is to use as little varnish as possible and to apply that by brushing it well. Never flow the varnish on thickly, as if finishing a table top or floor. Take one tip or joint at a time. When you come to a winding, brush around the threads, rather than across them. Work in a good light. As you reach the guides, varnish under them, working with the tip of a camel's-hair brush under the beginning of the shoulders, which is a vulnerable place for the entrance of water.

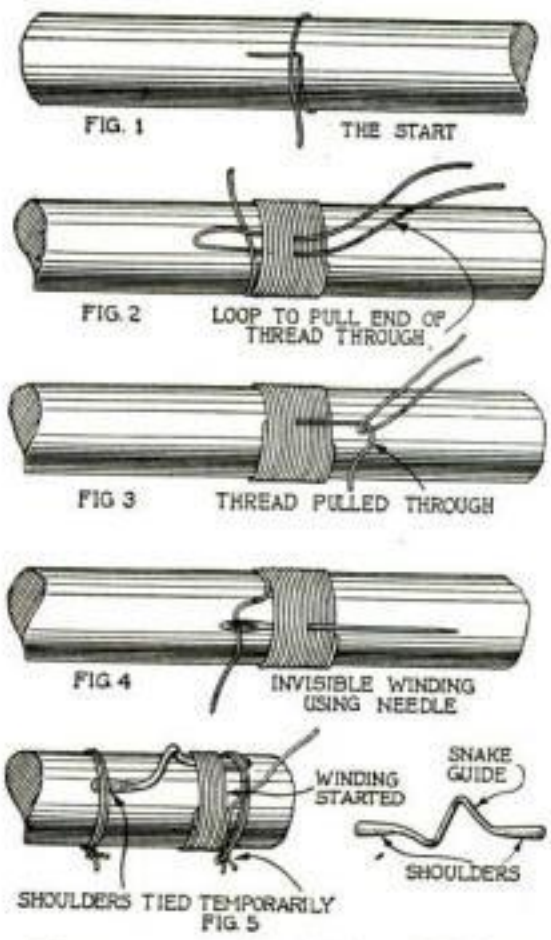
Hang the sections in a warm, dustless room and let the first coat dry for a week or ten days. The drying process can be hastened without harm by hanging the sections in the wind, out of doors in a shady spot.

From three to five coats of varnish may be applied, depending upon the consistency of the varnish.

When the last coat is hard, rub the rod lightly with fine powdered pumice stone and water. Wash now and then with cold water to see that *(Continued on page 93)*

New Rods for Old

(Continued from page 92)

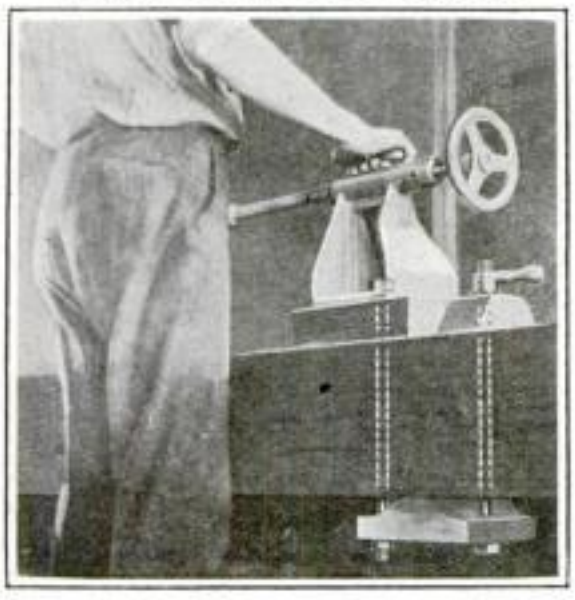


Two ways to end a winding invisibly and method of attaching a snake guide

you are not rubbing through the varnish. As soon as the surface is smooth, dry the sections and go over the whole with dry rottenstone, which will give it a polish. A soft piece of chamois skin can be used to give a final polish.

The fact that very few amateurs give their rods this final care and polishing accounts for the fact that their rods are rough rather than beautiful. The polishing completes the refinishing process.

Clamps for Wood-Turning Lathe Save Stooping



How a wooden or iron rocker arm is used to bring the clamping handle above the bed

TO CLAMP the tailstock and tool rest on a wood-turning lathe of the type illustrated, the workman ordinarily must reach underneath the lathe. Adjustments may be made more conveniently if the clamping device is rearranged so that the handle is above the lathe bed. This is accomplished by the addition of a long bolt and a wooden or iron rocker arm.—JONAS J. BYBERG.

The SHIPSHAPE HOME

Pointers on Brushing Lacquers

How to Prepare the Surfaces—The Undercoats—Straightening Out Rough Spots and Laps

By BERTON ELLIOT

MRS. ANDREWS, who lives across the street from us, was on the phone.

"I've got a fine idea!" she announced, with her usual enthusiasm. "Some of the ladies in our card club have been finishing things with the new brushing lacquers. I guess I started them; anyway, it's quite the popular thing now. Some of them have done really nice work—breakfast sets, dressers, end tables, telephone stands, tilt tables, door stops, magazine racks, book troughs, candlesticks, book ends, bulb bowls, and everything. Of course, there were some things that didn't turn out just right, and most everybody has some question they would like to have answered.

"Well, next week, the party's at my house," she went on breathlessly. "I thought I'd have it on Saturday afternoon instead of the regular Thursday, and get you to come over after we're through playing bridge. Then those who wanted to could stay for a while and ask you questions."

Four o'clock Saturday afternoon found me the center of a much interested little group of amateur painters, all eager to receive information.

"Suppose we start there," I suggested, nodding to one of the women at the extreme end of the room, "and go around the room to the right, each asking a question. Now for the first one."

"I lacquered our kitchen table and chairs in jazzy breakfast room colors," my first questioner said, "and you never saw a better looking breakfast set, but a spot on the table about the size of a dollar has refused to dry."

"Your trouble is undoubtedly due to oil or grease which was not thoroughly cleaned off," I replied. "A kitchen table is apt to have greasy deposits. Very likely some grease soaked into the wood in this spot, and your sandpapering did not remove it. You should have scrubbed the top vigorously with a good kitchen cleansing powder—about half a cupful to a pail of hot water. The surface then should have been rinsed with clear water with a little vinegar in the proportions of a pint of vinegar to a pail of water. Of course, this would have made it necessary to wait overnight for the table to dry thoroughly. A quicker way to remove the grease in a case like this is to wash the table with denatured alcohol."

"Isn't gasoline excellent for removing grease?" asked one of the women.

"Gasoline is often used for that purpose. It should be high test gasoline, scrubbed on generously. There is some objection to gasoline for this purpose because it has a tendency to spread the grease in a thin film over a larger surface instead of removing it. In preparing a surface for lacquer, one must be especially cautious and, therefore, the other cleansing methods I have mentioned are safer. At the same time, gasoline is commonly used and in most cases, no doubt, it is quite satisfactory.

When too much brushing has left a rough spot, an application of lacquer thinner usually will straighten out the surface

"To return to our kitchen table, since we cannot get the grease off at this late stage, I suggest that you try coating over the spot with white shellac. It will undoubtedly seal in the greasy or oily deposits. When thoroughly dry, sandpaper lightly, 'feathering' the edges so they will taper up neatly from the old surface. Give the entire top of the table another coat of lacquer, being especially careful to go lightly over the shellacked spot so as not to cut through into the grease again. Now, let us have the next question."

"I lacquered a dresser that had been previously finished and the lacquer seemed to act as a paint and varnish remover. Why was that?"

"There are several things that may have caused this. You see, the solvents used in quick drying lacquers are very powerful. Under certain conditions they will soften a paint or varnish coating and lift it from the surface. If the lacquer is brushed too much, it will pull up the softened undercoatings. It should be flowed (Continued on page 95)

Pointers on Lacquer

(Continued from page 94)

on quickly and freely with generous brushfuls. I take it, however, that this was not the fault in your case. What probably caused the trouble were breaks in the surface, which permitted the lacquer solvents to get under the old paint film. If the old finish is chipped off, or if it is checked or alligatored, sometimes it will do this. Of course, the surest way of producing satisfactory results, where a high class job is desired in refinishing, is to remove the old coatings and build up a new finish from the bare wood. The most general practice in amateur painting, however, is to coat over the previous finish. Where there are breaks and abrasions in the surface and there is any doubt about its being suitable for refinishing with lacquer, the application of a coat of shellac, to seal over the surface and fill the abrasions, will, in ninety-nine cases out of a hundred, prevent the lacquer getting under the surface and will generally permit a creditable job. And if it doesn't, it hasn't taken very long to apply, and you can then take off the old finish. To remedy the trouble you have gotten into, sandpaper the surface thoroughly to smooth down the roughness caused by the lifting up of the old coating. Then apply a coat of shellac, or, preferably, two coats, sandpapering each coat very lightly, and apply another coat of lacquer. This will fix it up, I am sure. Now I'm ready for the next question."

"I USED brushing lacquer on our floor, and within a few days it began to come off. It was a hardwood floor, and I used clear lacquer."

"There was most likely some foreign substance on the floor which prevented the lacquer from holding tight—undoubtedly grease, dirt or moisture. The presence of any of these will have a tendency to prevent lacquer from drying thoroughly. Floor oil, wax, furniture polish, and dustless mop preparations generally are of a greasy nature, and the safest way in refinishing a floor with lacquer is to wash the surface in one of the ways I mentioned before. It is much more necessary that the surface be free from grease, dirt and moisture (especially grease) when lacquer is to be used than with the old type of paint and varnish materials. Be sure to remember this. Now for the next question."

"I did some lacquering the other day and it seemed to drag under the brush. I had an awful time to prevent showing laps."

"It's plain to see that you are just starting to use brushing lacquer. Some people do have a little trouble of this kind with lacquer before they become accustomed to it, but they soon get the knack of using it. It's really easy when you get the idea. Lacquer must be applied with a full brush and flowed on freely, holding the brush at an angle and not straight and stiff. Don't scrape most of the lacquer off on the edge of the container and don't try to brush it out. If you do, you are bound to have trouble. Try another piece—starting in on the smaller surfaces, (Continued on page 97)

Ⓢ This seal on a radio, tool or oil burner advertisement signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Save Hours with this Guaranteed Lacquer

["Rogers" dries hard in 30 minutes. Just brush it on!]

Everywhere, people are amazed and delighted at the speed and ease with which Rogers Brushing Lacquer works. It is almost magical.

No tedious preparation is needed. "Rogers" goes on *right over the old finish*. This saves a lot of time. Then it does not require long, expert "brushing out"—because it covers readily and spreads easily. You merely *flow* it on with a full brush. This, too, saves time. "Rogers" forms a beautiful, tough colorful film that sticks tightly to any new or old surface. Then, it

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Dealers everywhere carry "Rogers." Comes in cans, mixed and ready for use. Your choice of 18 wonderful colors—also black, white and clear. For best results insist upon the genuine in the "Oriental" can. Read our publicly advertised "Money-back" Guaranty to the right.

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Pointers on Lacquer

(Continued from page 95)

such as chair rounds and legs. If you still have trouble, it may be the brush. A soft bristle brush, such as fitch or bear hair, should be used."

"THAT reminds me of some trouble I had," said one of the women. "I've done quite a lot of lacquering, and as a rule I don't have a bit of trouble, but the other day I was doing a chair and was interrupted when I was working on the top panel. Before I knew it, the material had set up a little, and I roughened it up into quite a 'mess.' I couldn't get it smoothed out. There must be some way of fixing it."

"So there is," I assured her, "although surprisingly few know it. Always have an open can of 'thinner' near by. If you run into anything of this kind, dip the brush in the thinner at once and mop it quickly over the spoiled place. Brush just enough to straighten out the surface. then leave it alone. The thinner will melt the lacquer, as it were, so that it will usually flow out again and level itself without showing brush marks."

And here the discussion ended. for no one could think of more lacquer problems.

If you have questions about brushing lacquer not touched upon by Mr. Elliot, he will be glad to answer them by mail. Please inclose a self-addressed and stamped envelope.

"Dustless" Door Mat

UPON returning from the garage or cellar workshop, one is apt to leave footprints of concrete dust upon waxed or polished floors. Wiping the feet hastily upon a mat at the door will not always remove the white dust. If, however, the

If treated with a little oil, a cellar door mat will take up concrete dust more readily

mat is impregnated with a teaspoon of light machine oil in a pint of gasoline, the very act of walking over it will be sufficient to dust clean the soles of one's shoes. This small amount of oil in a mat will not cause oily marks to be left upon rugs or carpets.—R. WAILES.

BEFORE applying white enamel, fill nail holes in the woodwork or plaster with putty made by thickening flat wall paint or enamel undercoater with cornstarch or whiting. This will not discolor the enamel later as common putty, made with linseed oil, is apt to do.

You Can Build a Viking Ship

Our Blueprints Will Assure Your Success in Making a Highly Picturesque Model

By Capt. E. Armitage McCann

Captain McCann at work on the latest Popular Science Monthly ship model. Full size drawings of the ship are contained in Blueprints 61 and 62 (see page 101)

OLAF TRYGGVASON'S "long serpent" had thirty oars a side; one of Canute the Great's ships had sixty. The Viking ship model we are building is a sextensesse, with sixteen a side, which means that her prototype had sixty-four rowers and a crew of from seventy to eighty.

Those who would like to build this model of a Viking ship, but have not read the two previous articles in April and May, can obtain full size drawings of all the parts and a complete list of materials by sending for Home Workshop Blueprints Nos. 61 and 62 (see page 101).

The mast step (page 99) may be made next. The base block is notched underneath to take three frames. The mast steps in a square hole 3/16 in. deep, located 1 1/4 in. from the forward end. Use a piece of straight grained pine or a 1/4-in. dowel stick 12 in. long for the mast. Taper it to about one third less at the upper end.

Stern of the famous Oseberg ship, which was dug up in a remarkable state of preservation

Ship the mast and on the aft side of it erect a post 1/4 in. square. Next make two side chocks or partners, 1/8 by 7/16 by 2 in., and cut notches in them about 1/8 in. square to receive the wedge that holds the mast upright. Glue and pin the step block fair along the center of the keelson.

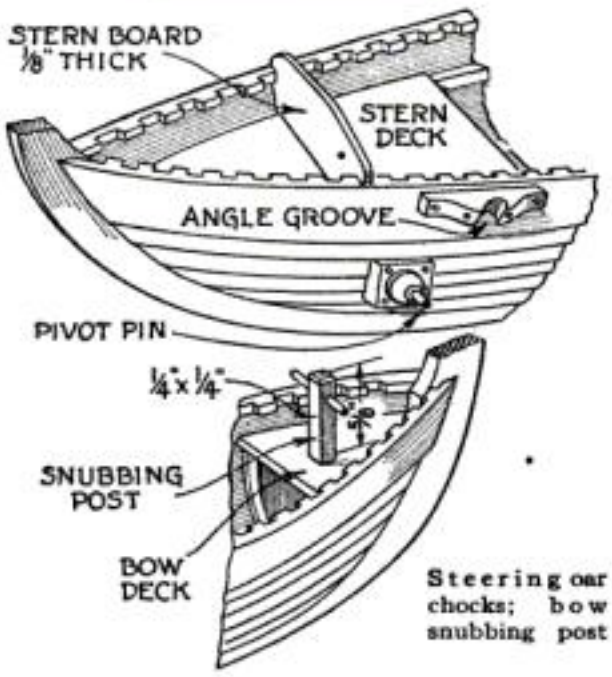
To fasten a post and beam or other light parts together, bore nearly through them and press in the pin with the pliers, as shown on page 80, May issue. Cut off the end and clinch it. In practice the writer has found it advisable, where possible, to use nails, pins or pegs, to aid the glue, as a model has to stand rough usage and many onslaughts of the feather duster.

On the after deck place the stern board (page 99). Then we may as well make the chocks for the steering oar. Both are of semi-hardwood. The upper is 3/16 by 3/4 in. It is glued and nailed outside to the gunwale on the starboard side with its center about 1/2

(Continued on page 99)

A Viking Ship Model

(Continued from page 98)



Steering oar chocks; bow snubbing post

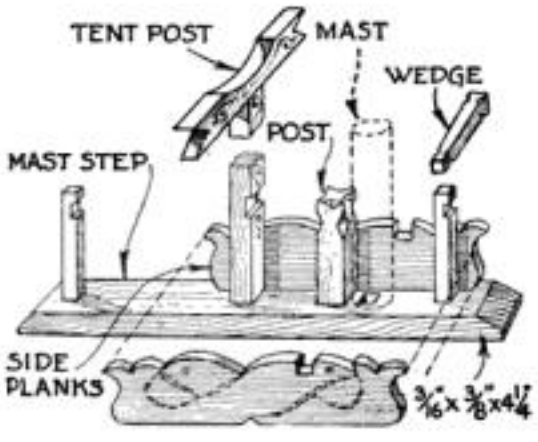
in. abaft the front edge of the after deck. From the plank on which the helmsman stood or "steerboard" side, comes our modern name of "starboard" for the right-hand side of a vessel. The other was the "leerboard" or "larboard" side, meaning the empty side; this word larboard was later changed to port, to save confusion. "Port" is from the Portuguese, meaning the open side, which was laid next to the quay.

The lower chock is like a cone on a board. Take a piece 3/16 by 3/8 by 3/4 in., cut one flat side to fit on the planking 3/4 in. (center to center) below the upper chock and 1/2 in. abaft it, and through the center bore a slanting hole 1/16 in. in diameter. This hole is at a right angle with the keel and horizontal when the block is in position. With the outside end of the hole as a center, whittle the block to the shape of a cone with flat ends, and glue and nail in position.

From the middle of the forward deck there projects a post for the anchor cable, as shown above.

The supplementary carvings for the head and tail of the dragon may now be made. Fret-saw two outlines as shown on page 100 and full size on Blueprint No. 61. Note that the outline differs from that of the centerpiece. With a knife or other tools, carve them to make prominent the ears and the mane; cut in the center of the ears and the eye sockets; cut the teeth back a bit from the edge of the lips, and run an incised line to mark the outside of the lips.

For eyes, I glued in rubies from a notion counter (Continued on page 100)



Mast step with one side plank moved out of place to show the construction

Toy "Sub" Dives and Rises

By Hi Sibley

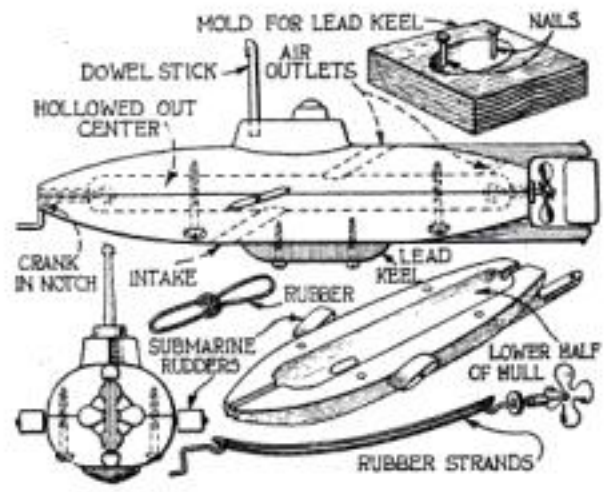
THIS bathtub submarine, properly balanced, will perform amazing feats. When released on the surface with planes set for submerging, it starts under with a whirr and gurgle, and a stream of bubbles from the air outlet back of the conning tower marks its course. It will turn in a limited space and will come up gradually after the speed slows down.

Any easily worked wood may be used. The ballast can be melted from scrap lead. Have the mold large enough so that the keel can be filed down until the "sub's" water line is just over the propeller when floating idle. Make the galvanized sheet iron propeller as large in diameter as the rudder supports permit.

The toy submerges like a real submarine and when the motor runs down, it comes up

The rudder and elevating planes will swell on their axes and be tight enough to maintain any position in which they are set.

Paint the boat slate gray and apply several coats of spar varnish. Bright vermilion will set off the propeller to advantage, and a row of brass-headed upholstery tacks will give the appearance of rivets.



How the "sub" is made. The hull proper is 10 in. long, 2½ in. wide and 2 in. deep

It goes without saying that the little submersible can be made in various sizes. Lightness is not a requisite; in fact, a heavy wood would be preferable. If a larger boat is built, the motor can be made with heavy rubber bands such as are sold for model airplanes.

You Can Build a Viking Ship

(Continued from page 99)

To complete the dragon's head, two fret-sawed and carved pieces have to be added

brooch. This is very effective, but red beads or pinheads painted red will serve.

The dragon's or serpent's head was made as fearsome as possible to frighten the enemy and had eyes so that the ship could see to keep out of danger, as with Chinese boats to this day.

The tail is the natural complement to the head. Two small sidepieces are cut to the shape given on the blueprints and carved with a flowing tail effect.

All four pieces are glued to the centerpiece and clamped until firm.

The hull is now ready for coloring. I gave all of what we have so far made, with the exception of the long posts, a coat of rather dark oak stain—a little darker outside than inside. I then took some black stain and painted all the outside of the centerpiece, including the head and tail carvings, the outside of the gunwales and the mast step. When the stain was dry, I rubbed the hull diagonally and very lightly with some fine steel wool to remove a little of the stain from the edges of the planks, thus emphasizing them.

Everything was then given a thin coat of shellac varnish. The long posts of brown wood were varnished only.

The tongue is bright red; inside the ears and along the jaw, a duller red. The teeth are gilded, as are the edges of the ears, mane and eyebrows. At the tail the carved plumes are gilt. The scroll-work along the stem, stern and keel, to be described later, will also be gilt. This gold work should be reasonably bright, but not too glaring.

Next month we shall make the rest of the small parts, the sails and the base, and finish the decorating.

To make a light gray-green shingle stain, mix one part pure boiled linseed oil, one part flatting oil and one part creosote. Add a little white lead to give it body and tint with chromium oxide, toned down with a very little lampblack.

Blueprints for Your Home Workshop

Nos. 2 and 15

ANY ONE of the blueprints listed below can be obtained for 25 cents. The blueprints are complete in themselves, but if you wish the corresponding back issue of the magazine, in which the project was described in detail, it can be had for 25 cents additional so long as copies are available. The Editor will be glad to answer any specific questions relative to tools, material, or equipment.

POPULAR SCIENCE MONTHLY
250 Fourth Avenue, New York

GENTLEMEN:

Send me the blueprint, or blueprints, I have underlined below, for which I inclose.....dollars.....cents:

No.	*Title*	*Described in Issues of*	*Price*
1.	Sewing Table	Feb., '22	25c
2.	Smoking Cabinet	Mar., '22	25c
3.	End Table	Apr., '22	25c
5.	Kitchen Cabinet	May, '22	25c
8.	Shaving Cabinet	June, '22	25c
9.	Arbor, Gate and Seats	July, '22	25c
10.	Porch Swing	Aug., '22	25c
11.	Bench and Tilt Table	Sept., '22	25c
12.	Electric Washer	Oct., '22	25c
13.	Tea Wagon	Nov., '22	25c
14.	Christmas Toys	Dec., '22	25c
15.	Workshop Bench	Jan., '23	25c
16.	Inlaid Radio Cabinet	Feb., '23	25c
17.	Cedar Chest	Mar., '23	25c
18.	Phone Table and Stool	Mar., '23	25c
19.	Grandfather's Clock	Apr., '23	25c
20.	Flat Top Desk	Apr., '23	25c
21.	Colonial Desk	Apr., '23	25c
22.	Cabinet and Desk	Apr., '23	25c
23.	Pergola Garage	May, '23	25c
24.	Gateleg Table	June, '23	25c
25.	Canoe Sailing Outfit	July, '23	25c
26.	Baby's Crib and Pen	Sept., '23	25c
27.	Kitchen-Cabinet Table	Oct., '23	25c
28.	Pullman Play Table	Nov., '23	25c
29.	Toy Tea Cart, etc.	Dec., '23	25c
30.	Tool Cabinet, etc.	Jan., '24	25c
31.	Sewing Cabinets	Feb., '24	25c
32.	Chinese Game Table	Mar., '24	25c
33.	Dining Alcove	Apr., '24	25c
34.	Garden Trellises	May, '24	25c
35.	Simple Radio Cabinet	Oct., '24	25c
36.	Rush-Bottom Chair	Nov., '24	25c
37.	Simplified Bookcase	Dec., '24	25c
38.	Sheraton Table	Jan., '25	25c
39.	Salem Chest	Feb., '25	25c
40.	Desk in Sheraton Style	Mar., '25	25c
41.	One-Tube Radio Set	May, '25	25c
42.	Three-Stage Amplifier	June, '25	25c
43.	Four-Tube Receiver	July, '25	25c
44.	Pirate Ship Model—Hull	Feb., '26	25c
45.	Pirate Ship—Details	Mar., '26	25c
46.	Galleon Model—Hull	May, '26	25c
47.	Galleon Model—Details	June, '26	25c
48.	Sailing Yacht Model	July, '26	25c
49.	Broom Cabinet	Aug., '26	25c
50.	Airplane Model (Flying)	Sept., '26	25c
51.	Clipper Ship Model—Hull	Oct., '26	25c
52.	Clipper Model—Details	Oct., '26	25c
53.	Clipper Model—Rigging	Nov., '26	25c
54.	Five-Tube Radio Set	Oct., '26	25c
55.	Five-Tube Set—Details	Oct., '26	25c
56.	Bird and Animal Toys	Dec., '26	25c
57.	*Constitution* Model—Hull	Jan., '27	25c
58.	*Constitution*—Rigging	Feb., '27	25c
59.	*Constitution*—Rigging	Feb., '27	25c
60.	Welsh Dresser	Mar., '27	25c
61.	Viking Ship Model—Hull	Apr., '27	25c
62.	Viking Ship—Details	Apr., '27	25c
63.	Toy Motor Boat—Hull	May, '27	25c
64.	Toy Motor Boat—Details	May, '27	25c
65.	Six Simple Block Puzzles	June, '27	25c

Name .....
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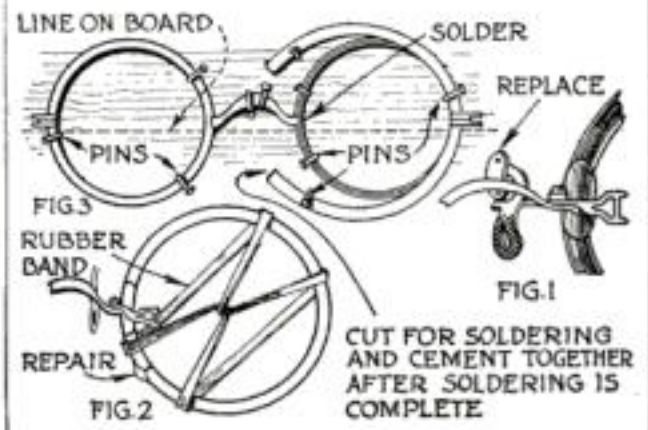
How to Repair Amber Rim Eye Glasses

IMITATION amber used in so-called amber rim glasses is a form of celluloid, which often can be repaired satisfactorily by using celluloid cement.

One of the easiest repairs to execute is the replacement of a small piece of celluloid on the nose piece of nose glasses (Fig. 1). It is necessary only to hold the glasses in position so that the gold piece with its two rivets is flat. Put on a quantity of the cement, making sure that it runs in around the rivets; then blow it a little to harden the outer surface. Do the same thing with the other side. The following day use a fine file—a nail file will do—to dress the cement flat.

Another simple job is to cement a broken rim together. Nose glasses are generally fitted with a celluloid rim without a brass insert and break easily. To repair them, put the lens in place and hold the rim together with a rubber band as shown in Fig. 2. Cut or file a V-shaped groove at the joint and fill it with cement.



Three types of repairs that may be made to amber glasses by using celluloid cement

To be doubly safe, a thin piece of sheet celluloid may be covered with cement and laid over the joint; this is trimmed after the cement is hard.

If the crack occurs under the gold clip, put cement on each end of the rim and clamp together with a rubber band.

A third common repair job is to solder a nose piece to the gold rim insert of amber rim glasses. Remove the lenses and bows by loosening the screws near the bow hinges. Mark the lenses with gummed stickers so you can replace them properly when the job is complete.

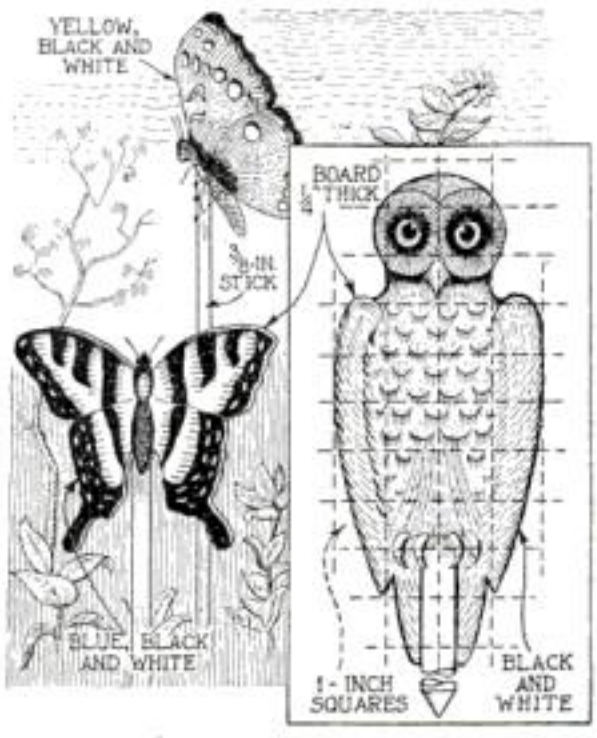
Cut the celluloid rim at the nose piece so that it can be spread apart. Lay the frame on a soft board on which a straight line has been previously drawn so the hinges and ends of the nose piece can be lined up. Hold the frame in place by driving three or four pins around inside of each rim and bending them over (Fig. 3). Spread the ends of the celluloid rim apart and hold with pins so that the heat will not melt the composition.

Solder with an iron or torch, being very careful not to heat the celluloid. Then trim the amber rim to compensate for the additional metal on the frame. Remove pins and cement the frame together as previously described.

The cement may be colored, if desired, by dissolving a piece of colored celluloid in it.—Boyd R. Alvord.

This seal on a radio, tool or oil burner advertisement signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Fret-Sawed Plant Sticks Enliven a Garden



Three designs for plant sticks. The butterflies are 7 or 8 in. long, and the owl, 10 in.

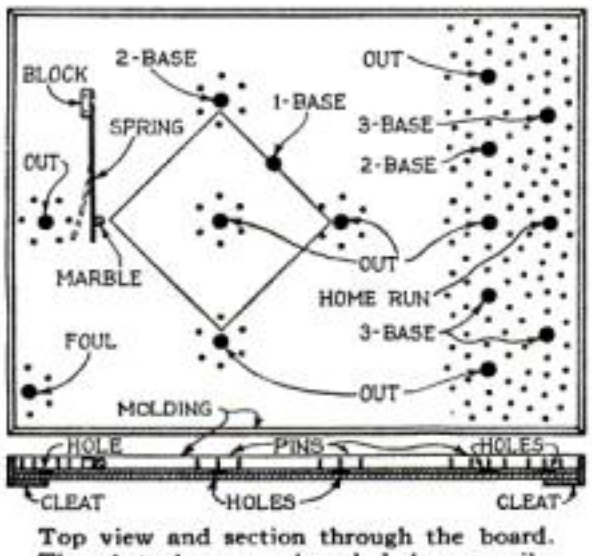
THESE plant sticks are excellent projects for those who find pleasure in simple woodwork. They are made with a coping saw, painted in bright enamel colors, and mounted on sticks 3/8 in. square and about 36 in. long, or long enough to bring them in their natural relation to the foliage.

The wood should not be more than 5/16 in. thick. When the forms have been cut out, it is well to give them and the sticks a coat of white lead and oil before coloring them. The sticks may be painted green or brown.—C.A.K.

Easily Made Baseball Game for Young Children

A BASEBALL game for amusing small children can be made as shown below.

A baseball diamond is laid out on a piece of wallboard 3 by 4 ft. (or smaller)



Top view and section through the board. The obstacles around each hole are nails

and holes slightly larger than the marble to be used are bored in the positions indicated. This is glued on a foundation made of wood or wallboard. Then 1½-in. wire brads are driven in where shown, and a spring arranged to "bat" the marble. The result of each "hit" is decided by the hole in which the marble rolls.—W. J. EDMONDS, JR.

LIFE IS NOT WORTH LIVING

—*Without Sound Nerves*

YOUR nerves govern your life — your efficiency, your happiness, your health. If your nerves are depleted, you cannot concentrate or think clearly; you have not the "pep" and spirit to enjoy your pleasures and sports; you have not the physical comfort and well-being w i t h o u t which happiness is *impossible.* Is life worth living under these conditions? No! You merely exist—you are not getting out of life *everything* that it has to offer!

PAUL VON BOECKMANN
Author of "Nerve Force" and various other books on Health, Psychology, Breathing, Hygiene and kindred subjects, many of which have been translated into foreign languages.

We are living in an age of SPEED; we are leading a "mile-a-minute" life. We crowd two, or even *five* years of life into a single year! We hurry, we worry, and often, we dissipate our vital forces through ignorance. We commit these sins because we are living in an age of acute competition, tremendously high cost of living, reckless pleasures—conditions that *compel us to strain our nerves to the utmost.*

Yet, we go on living our lives hard and fast, little realizing that we cannot go on for long, that there must come an end to our stock of Nerve Force, and that Nerve Exhaustion is staring us in the face!

Every victim of Nerve Exhaustion, when he is stricken with this terrible malady, firmly believes that he has been stricken *suddenly.* This is *not* true. The fact is, that it has been *years* developing, and that he has had many, many warnings of what was coming—but he did not heed them! Though he passes through years of subnormal nerve supply, he pays no attention; he believes it quite common—as many misled people do—to feel tired and worn out; to suffer sleepless nights in periods; to feel discomfort after meals; to feel depressed, irritable, melancholy, and often in a "mental fog." He believes his trouble will solve itself "somehow," "sometime," especially since his physician assures him that there was "nothing physically wrong," that all his "organs are perfect," that all he needs is a "rest" and he will be "all right." A little rest helps a *little*—for a while, and then he is right back where he started, leading the same old life. Finally he becomes a bit discouraged, believes that every man must endure "a few discomforts," and keeps going *while the going is still good.* Little does he realize that every day he is undermining his constitution, paving the way to all sorts of physical and mental disorders, and going through life only HALF ALIVE!

The country is teeming with cases that fit this story like a glove, for we Americans are the most nervous nation under the sun, not barring even the hot-headed Latins. They may be called "near-neurasthenics." A near-neurasthenic is but a next-door-neighbor to a full fledged neurasthenic, in the grip of *actual, terrible and complete* Nerve Exhaustion—Nerve Bankruptcy!

There is but one malady more terrible than Nerve Exhaustion, and that is its kin, Insanity. Only those who have passed through a siege of Nerve Exhaustion can understand the true meaning of this statement. It is HELL; no other word can express it. At first the victim is afraid he will die, and as it grips him deeper he is afraid he will not die; so great is his mental torture. He becomes panic-stricken and irresolute. A sickening sensation of weakness and helplessnes overcomes him. He becomes obsessed with the thought of self-destruction.

The symptoms of Nerve Exhaustion vary according to individual characteristics, but the development is usually as follows: First stage—lack of energy and endurance; that tired feeling. Second stage—nervousness, restlessness, sleeplessness, irritability, loss of hair, nervous indigestion, sour stomach, gas in bowels, constipation, irregular heart, poor memory, lack of mental endurance, dizziness, headache, backache, neuritis, rheumatism, and other pains. Third stage—serious mental disturbances, fear, undue worry, melancholia, dangerous organic disturbances, suicidal tendencies, and, in extreme cases, insanity.

If only a few of the symptoms mentioned apply to you, especially those indicating mental turmoil, you may be sure that your nerves are at fault—that you have exhausted your Nerve Force.

Perhaps you have chased from doctor to doctor seeking relief for a mysterious "something the matter with you." Each doctor tells you that there is nothing the matter with you, that every organ is perfect. But you *know* there is something the matter. Your doctor may prescribe a drug—a nerve stimulant or sedative. Leave nerve tonics alone. It is like making a tired horse run by towing him behind an automobile.

And don't be deceived into believing that some magic system of physical exercise can restore the nerves. It may develop your muscle but it does so at the expense of the nerves, as thousands of athletes have learned through bitter experience.

I have for more than twenty-five years given courses of instruction in Nerve Culture by mail. Over **100,000** people have learned through me how to care for their nerves and how to free themselves of the organic and mental disturbances that originate in nerve abuse.

Over a million copies of my book, "Nerve Force" have been read by people with high-strung nerves who have learned through my advice how to avoid nerve strain and how to care for their nerves. The cost of the book is only 25 cents (coin or stamps). Address Paul von Boeckmann, Studio **1416X**, **110** West **40**th Street, New York City.

Order Nerve Force today. It is *not* a pamphlet advertising my course, but a real book, 64 pages, illustrated. The latest edition of Nerve Force contains important information heretofore imparted to private pupils only. Nerve Force is on file in many public libraries, and at the Medical National Library at Washington. Thousands owe their recovery from nerve exhaustion to reading this book. Your money refunded if the book is not all you expect.

A physician writes as follows: "I am writing you as a Graduate M.D. to say that I have carefully read your excellent book on 'Nerves.' It has done me more good already than anything I have seen or tried and I think it easily worth a hundred times what I paid for it. It is impossible to read it without ***feeling*** *the wonderful* ***Truths*** *it reveals."*

A school teacher writes: "I had the opportunity of reading Paul Von Boeckmann's 64-page book 'Nerve Force.' I completed it in one reading. One feels at home and understands unfathomed ideas concerning nerves, mind, and body. As I was reading, a stranger approached and remarked, 'That book cured me from what doctors called heart trouble, then stomach trouble, etc. I had nothing of the kind, I am now a well man.' "

Play Arbor Keeps Boys Happily Busy

Has Work Bench, Tool Chest, and Tank for Toy Boats

By Hi Sibley

MOTHER'S problem is to keep the children interested outside the house; father's is to keep the yard looking something more like residence property than a junk yard. And the problems are complicated if one lives in an apartment or bungalow court, where the back yard, if any, is very restricted—especially as boys will be boys, including the neighbors'.

The arbor playhouse illustrated is a simple but very effective solution. The most attractive playhouse ever built, by itself, will not keep lively boys interested all the time, but by the addition of a work bench, toy chest with lock, and a boat tank, you will find the youngsters in it a great part of their time. Moreover, they will be occupied in safe and wholesome recreation.

This particular playhouse has the double advantage of being inexpensive to build and serving as a home for all the toys and accumulation of odds and ends that otherwise would litter up the house and fill closets.

Most important, of course, is the boat tank, for it is an odd child indeed who is not fascinated by playing with boats, particularly with those crude but beloved craft of his own construction.

A general view of the arbor and the boat tank, which has borne a hundred ships on their maiden voyages

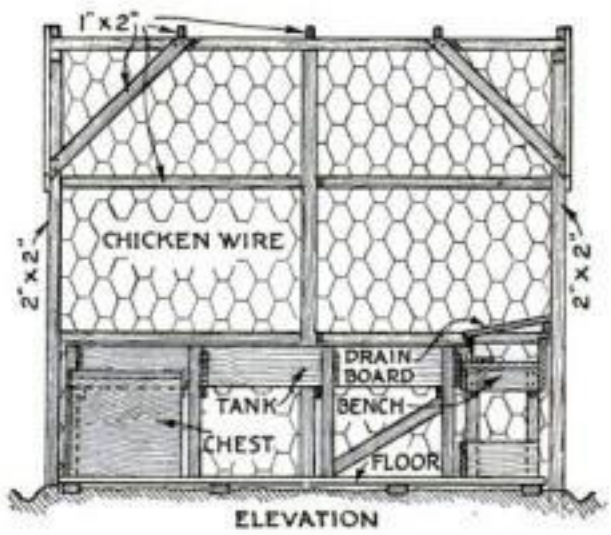
FOR the arbor itself all that is required are six pieces 2 by 2 in. by 8 ft. and ten pieces 1 by 2 in. by 8 ft. One of the latter is cut up into diagonal braces for the corners.

A floor is not absolutely necessary, but is worth more than the added expense, as some water will be slopped out of the boat tank. In the original of this design the floor was made up of odds and ends of boards picked up in a vacant lot; this served the double purpose of cleaning up the lot and providing free floor material.

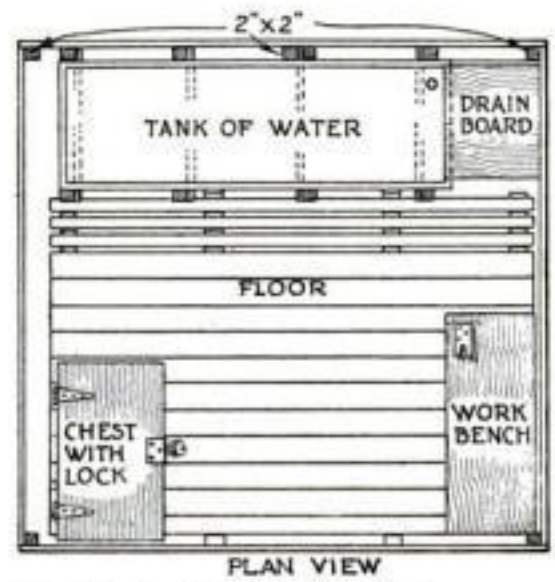
The boat tank, which is simplicity itself, will keep the children interested for hours at a time. Any size or shape can be made in this type of construction. It is well, however, to have it 5 or 6 ft. long, or even longer, to give a fair run for the self-propelled boats. During the hot weather the boys can actually get into the tank and splash around without damaging it. However, it is purposely built up from the ground to make it more difficult for the children to get in it and to kick dirt into it.

WORK BENCH

A simple way to construct the work bench



ELEVATION



PLAN VIEW

Typical elevation and plan. Both arrangement and dimensions may be modified

On account of the accumulation of debris in the tank—paper, sticks, even mud—there should be a drain hole an inch or two in diameter to carry off the dirty water. In California, where the original arbor was built, we utilized this water during the dry summer season for irrigating the plants and vines, and with astounding results. Each locality has its particular variety of fast-growing plants; here we placed morning glories on the east, and Japanese hop on the west and north. These completely covered the frame; they were set out between the frame and irrigation ditch. On the outside of the ditch a row of marigolds and cosmos was planted. All were chosen for fast growing as the arbor was built on a vacant lot and, therefore, temporary. For a permanent location, grapes, honeysuckle or ivy could be used as a covering.

IF NO bit is available large enough to bore a 1½ or 2 in. hole, mark a circle and drill smaller holes around this; then cut between the holes with a chisel and trim with a jackknife. Make a tapered wooden plug, wrap a piece of coarse sandpaper around the taper, and rotate in hole until the latter is smooth. This is the same principle as seating a valve in a gasoline motor.

Redwood was used in the original tank, but any clear lumber will do. The beveled edges of the bottom and side pieces as well as the end pieces, permit the hot tar to fill the joints nicely. A drainboard set at one end will serve to hold the boats when not in use.

The toy chest can be any large box. The cover is made waterproof with roofing paper or other material and fitted with hinges and a padlock hasp.

The space underneath the work bench will hold odds and ends of boards to be drawn upon when needed for the construction of new vessels and toys.

To make sure that too much litter would not accumulate around the workshop, an incinerator was built near by. This is simply an old wash boiler with the bottom knocked out, around which is banked an adobe wall. There is an ash pit door in one side.

It is nothing less than astonishing how much work has been done in this arbor. The boys have built toy transportation units for traveling by air, water and land.

How the wooden boat tank is put together

Home Workshop Chemistry

Simple Formulas that Will Save Time and Money

SHELLAC can be purified to such an extent that it makes a perfectly clear solution in alcohol. It then becomes much more valuable to the home worker than the common commercial grades of shellac. It can be used for protecting pictures and other delicately marked or colored surfaces; it also can be used as a finishing varnish on woodwork with the great advantage that it will not turn white in spots, as ordinary shellac is apt to do when affected by moisture.

Orange or flake shellac usually contains about 6 percent wax, 6 percent pigment, and 9 percent sand, wood fibers and other impurities. To remove these, dissolve 2 tablespoons of sodium carbonate in 2 qts. boiling water and add 6 heaping tablespoons of flake shellac. Cool the solution. The wax and other impurities will float upon the surface in a solidified mass, which may be removed by filtration. Carefully acidify the solution by adding slowly a few drops of hydrochloric acid while constantly stirring the liquid. This operation must be carried on in a glass or porcelain vessel. The granular light brown or yellow precipitate is collected on a filter and is melted in boiling water to remove excess water and to leave the shellac harder.

Preparing a filter to strain shellac

A good varnish is prepared by dissolving 3 oz. of the purified shellac in ½ pt. of denatured alcohol. Should the solution still be milky, the shellac probably has been adulterated with rosin and is not suitable for fine work.

Shellac is an excellent liquid filler for close grained woods, but it will not fill the grain of coarse woods. It can be colored by the addition of alcohol soluble dyes or concentrated alcohol stains; these should be added to the alcohol before the shellac has been dissolved in it.

A floor varnish may be made by using thick turpentine (Venice turpentine) or ozonized turpentine (two parts of the latter or one of the former) with twice its weight of shellac dissolved in 10 parts (by weight) of alcohol. This varnish is more flexible and, therefore, of greater durability, than shellac and alcohol alone, but it must always be remembered that shellac is quite soft compared with some of the other varnish gums.

Varnished and shellacked furniture ordinarily should not be touched by water, although a moist and slightly soapy cloth may be used to clean the surface if badly soiled. Otherwise a few drops of furniture polish or light lubricating oil on a cloth will revive the finish.

How to Build a Canvas Camp

(Continued from page 75)

How the platform and framework look before the canvas sections are put in place

may be inserted where desired after the sections have been sewed.

Brass grommets are placed where the guy ropes are to be fastened. These are inserted on the edge with a punch and die that can be obtained at any well stocked hardware store.

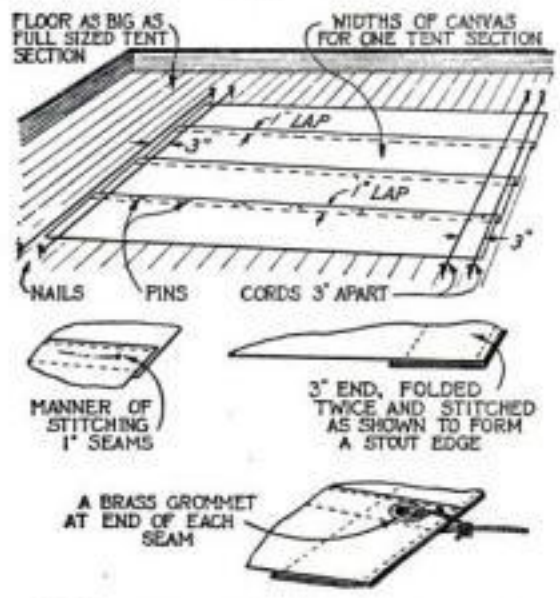
If a shower bath is desired, it can be constructed as shown below and covered with wood, or with building or roofing paper. The roof is wood, covered with roofing paper.

The roof of the tent itself can be wood, if preferred, like the roof of the veranda. Of course, no guy rails would then be necessary.

The lumber list for a camp of the size illustrated is as follows:

For foundation, 9 (or, better, 12) pcs. 8 by 8 in. by 2 ft. chestnut posts and 3 pcs. 4 by 4 in. by 19 ft. 6 in. oak or yellow pine sills.

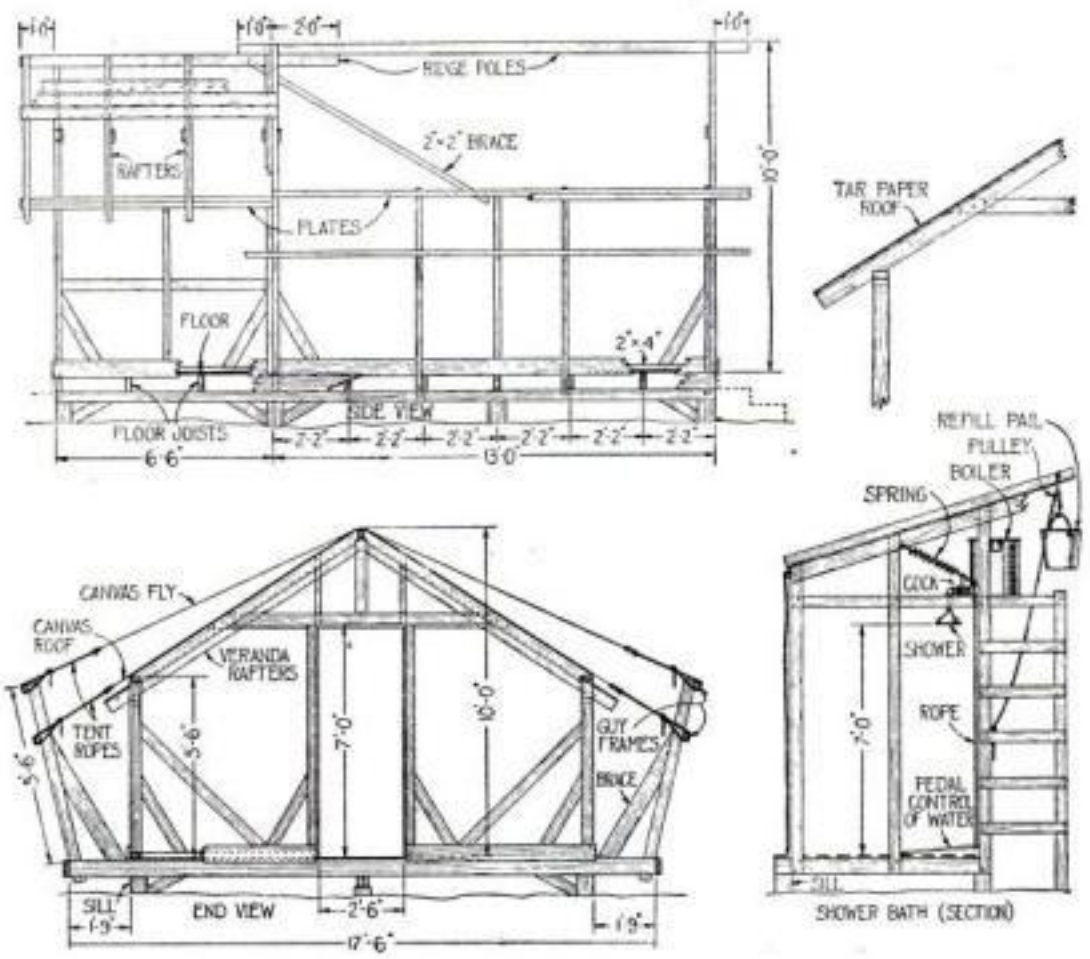
For the tent proper, 7 pcs. 2 by 6 in. by 17 ft. 6 in., floor joists; 2 pcs. 2 by 6 in. by 13 ft., cross floor joists at ends; 8 pcs. 2 by 4 in. by 6 ft., tent guy rail posts; 8 pcs. 2 by 6 in. by 5 ft. 6 in. tent guy rail post braces; 4 pcs. 2 by 2 in. by 15 ft., tent guy rails; 6 pcs. 2 by 4 in. by 5 ft. 6 in., studs; 2 pcs., 2 by 4 in. by 13 ft., plates; 4 pcs. 2 by 4 in. by 8 ft. 6 in., rafters; 1 pc. 2 by 4 in. by 15 ft., ridge pole; 2 pcs. 2 by 2 in. by 8 ft., ridge pole braces; 12 pcs. 2 by 4 ft. by 3 ft., corner braces; 2 pcs. 2 by 4 in. by 7 ft., door posts; 1 pc. 1 by 5 in. by 10 ft., cross door top piece; 1 pc. 2 by 4 in. by 9 ft. cross door top piece; 2 pcs. 2 by 4 in. by 17 ft. 6 in., plates on floor (across veranda and house); 2 pcs. 2 by 4 in. by 6 ft., plate on floor at door end; 1 pc. 2 by 4 in. by 3 ft.,



Each canvas section is laid out on the floor, pinned, and then heavily stitched

ridge pole support; 2 pcs. 2 by 2 in. by 2 ft. 6 in., door transom pieces; 2 pcs. 1 by 6 in. by 13 ft., floor sides at sides; 2 pcs. 1 by 6 in. by 6 ft., floor sides at end; 240 sq. ft. flooring.

For veranda, 3 pcs. 2 by 6 in. by 14 ft., floor joists; 2 pcs. 1 by 6 in. by 6 ft., floor sides at end; 2 pcs. 1 by 6 in. by 6 ft. 6 in., floor sides at sides; 4 pcs. 2 by 4 in. by 7 ft. 6 in., plates; 8 pcs. 2 by 4 in. by 9 ft., rafters; 6 pcs. 2 by 4 in. by 4 ft. 9 in., studs; 8 pcs. 2 by 4 in. by 3 ft., corner braces; 2 pcs. 2 by 4 in. by 7 ft., door posts; 1 pc. 2 by 4 in. by 9 ft. 6 in., ridge pole; 4 pcs. 2 by 4 in. by 6 ft., veranda rail; 115 sq. ft. flooring; 150 sq. ft. sheathing for roof.



Side and end view of the framework, details of the veranda roof, and a section through the shower bath, which is built entirely separate from the canvas house

Wooden Monkey Performs Balancing Stunts

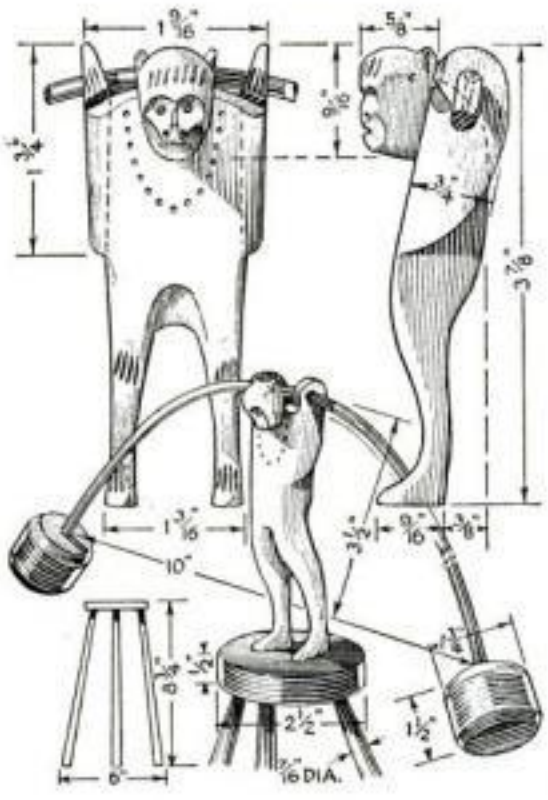
The monkey acrobat hanging by his toes

A REMARKABLE acrobat is this wooden monkey. It can balance on heels or toes in the most grotesque and apparently impossible positions and do all sorts of weird, rhythmic dances.

This novel toy, which is a favorite in India, usually is made of teakwood, but it can be whittled from any hard, tough wood. It can be made in various sizes and forms, but those indicated in the drawing below have proved satisfactory.

The balancing weights are of wood, and the bar which connects them and passes through the figure is stiff reed. This may be heated slightly and bent as necessary to obtain the most perfect balance.

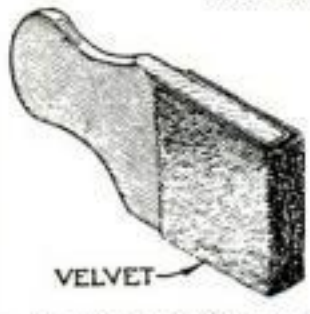
The model illustrated was made by a craftsman in India from teakwood. It is owned by Howard Wheeler of Baldwin, New York.



Front and side views to aid in whittling the figure; the balancing weights and platform

Applying Lacquer to Metal

A TOOL for applying lacquer to flat metal surfaces, which is in some respects superior to the camel's-hair brush usually employed, is nothing more than a paddle shaped piece of cigar box wood, about 1 in. wide at the end, around which a piece of velvet is glued. A wider swab is useful for dusting photos.—W. J. E.



A swab for lacquering flat metal surfaces

A Ball Bearing Merry-Go-Round

WITH a few pieces of lumber left over from building a house, an iron post, two discarded automobile bearings and some canvas, W. E. Robertson of Pelican, La., built the merry-go-round illustrated.

A 2-in. iron post 7 ft. long was set in the ground and fixed rigidly upright with concrete. A ball bearing was placed over the post on the concrete. On this was set a piece of lumber 2 in. thick and 12 in. square, a 2-in. hole having been bored in the center.

The bottom frame, in the form of a large cross, was made of two pieces 2 by 4 in. by 8 ft., with an outside rim of 1 by 4 in. boards. The frame was bored to go over the post and then fastened to the bottom of a long, narrow box made to inclose the post. It was also fastened to the block resting on the ball bearing.

The frame was floored with light boards and fitted with a railing of ½-in. pipe set 16 in. above the floor. An 18-in. opening was left for an entrance and four seats were fastened to the floor.

Over the post and within the upper end of the boxlike casing, a roller bearing was placed. The awning frame, 8 ft. in diameter like the floor, was made of four 1 by 6 in. by 8 ft. boards, tapering from 6 in. at the center to 1 in. at the ends. The outside rim was formed by ¼ by 2 in. strips.

This easy turning little merry-go-round was made almost entirely of odds and ends

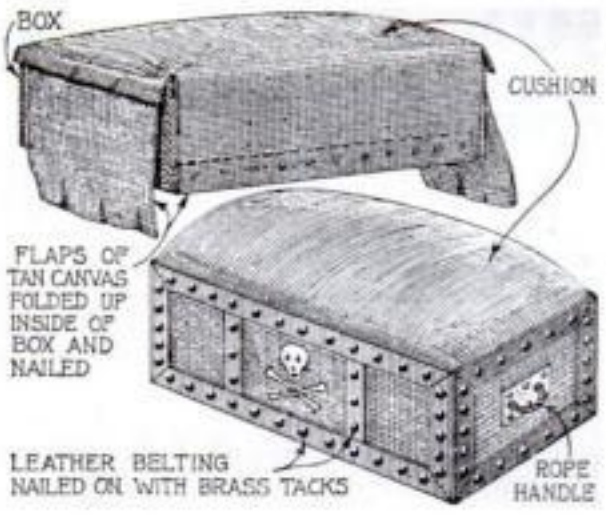
Usually one child sits in the entrance pushing on the ground with one foot to keep the merry-go-round turning, but the friction is so little that a child in one of the seats can keep it moving simply by pushing on the ground at intervals with a stick.—D. H. Rust.

Footstool Made in Form of Old Treasure Chest

A GROCERY box, some tan canvas from an old army tent, a piece of leather belting, a discarded cushion, a few brass headed upholstery nails and various odds and ends were converted into the treasure chest footstool illustrated.

The box was turned upside down, padded with the cushion and covered with canvas. The edges were trimmed with leather belting and handles were added. Then a skull-and-crossbones design was painted on the sides.—L. A. Langreich.

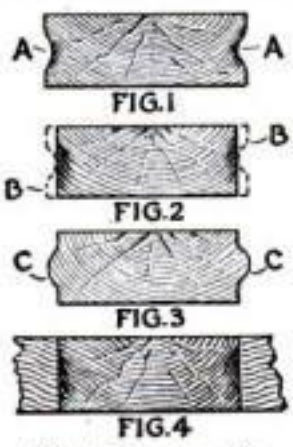
The footstool is a grocery box padded with an old cushion, covered with canvas, and ornamented with leather belting and tacks



How to Make a Wooden Joint Water-Tight

WOODEN tanks, pipes, decks, floors, partitions, and silos can be made watertight or practically so if the joints are prepared as indicated in the accompanying diagram.

The edges are grooved by compressing, not removing, the wood, as at A, Fig. 1. In the absence of suitable tools or machinery, this may be done by hammering or pressing a steel rod into the edge of the board or plank as far as can be done without breaking the wood fiber. The edges then are planed to the bottom of the groove, as at B, Fig. 2.



The four steps in forming the joint

If water is applied at this stage, it is obvious that the compressed fiber will expand, as at C, Fig. 3. Therefore, when planks or boards so prepared are nailed edge to edge, the effect of moisture is to make the joints watertight.

Any blacksmith can forge a flat, hooklike tool to be used with a hammer in making the groove.

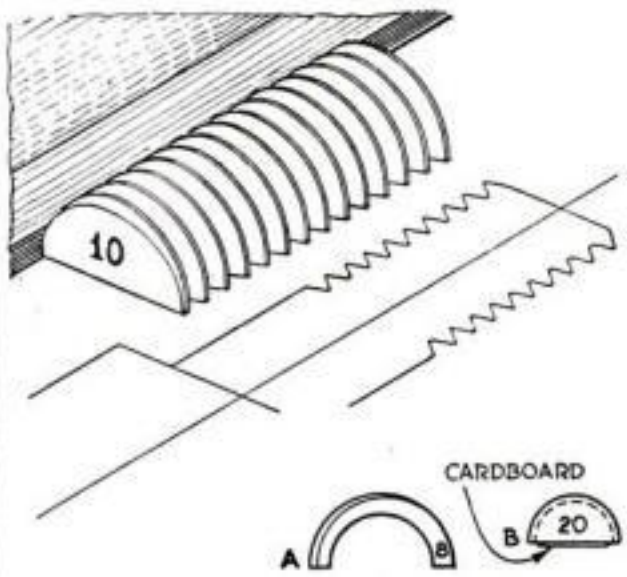
Quick Way to Draw Screw Threads

By Henry Simon

WE THINK of the simplest things last. This is perhaps the reason why it never occurred to the writer until recently to make thread templets like that shown in the illustration. Nothing could be simpler or more effective and reliable than to use the cross section of a screw in making a drawing of that screw.

About all that is required to make one of these templets is a piece of smoothly threaded stock, a haek saw, and a file. If the saw is used carefully, two templets can be made from each piece of threaded stock of the larger sizes. Ends of standard cap screws make good material, as the threads on the better makes of them are smooth and true.

The surface of the section must be straight and parallel to the center line. Its height should not be less than about three quarters of the radius of the outside



Templets to aid in drawing full size threads rapidly can be made from common cap screws

of the thread, as otherwise distortion of the thread form occurs. For instance, a templet made from ½-in. stock should not measure less than 3/16 in. from the top of the thread to the foot surface.

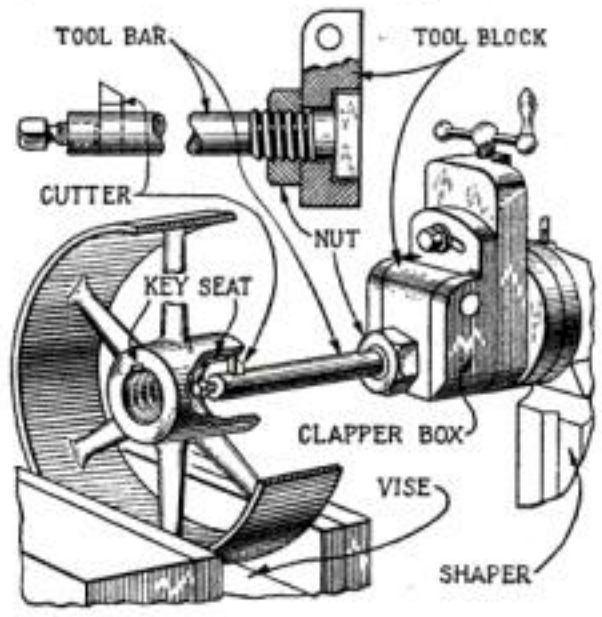
Where no surface grinder or miller is available, a good way to finish the surface of the cut is by placing a large, fine flat file on the bench and rubbing the piece on the file. In any case the surface should be finished by rubbing it in this way on a fine oilstone, in order to remove the burrs left from the former operations. The working edges are then given a final smoothing by drawing a piece of leather over them.

It is advisable to use for the finer threads SAE threaded screws, and USS for the coarser templets, because in that way there will be the least variation in the size of the templets. For example, the 20-thread templet can be made from ½-20 SAE. From 1 to 2 in. will be found a convenient length; this depends on the size of the thread. Templets of very large diameters should be made from stock from which the center has first been drilled out, as shown at A, as they will be lighter and time will be saved in finishing them. The number of threads should be stamped upon (Continued on page 110)

Using a Shaper to Cut Internal Key Seats

WHILE the larger shops do their keyseating of pulleys or gears on special machines and the lone mechanic in a factory repair shop must cut his with a chisel, there is a stage where neither method is exactly suitable.

Small shops frequently do such work on the shaper. That, however, is not so easy unless the proper equipment is provided. The accompanying illustration shows a tool holder that is useful for this work. It fits in the clapper block in



A shaper tool holder for keyseating, which replaces the tool post in the clapper block

place of the usual tool post. A large nut holds it tight.

Notice that there is no set screw shown in the side of the clapper box, and that the tool cuts on top. With the tool cutting on top, there is no need to lock the clapper. Of course, the same tool holder can be used for cutting on the bottom or side, as for die work, but for keyseating better results will usually be obtained if the tool is made to cut on top as shown.—J. E.

Quick Way to Draw Threads

(*Continued from page 109*)

both ends, or a flat can be filed on top and the number placed there.

For the finer threads, it is best to glue a piece of cardboard about .010 in. thick to the foot surface, with the edges about $\frac{1}{32}$ in. back from the root diameter, as shown at B. This will enable the draftsman, by slightly inclining his pencil, to get under the edge and thereby to produce a more accurate form.

There is no comparison at all between the rapidity with which work can be done with one of these templets and the usual way of laying out the thread, with divider and triangle. The templet method lays the work out so that the division is even and true. Puncturing of the paper with divider marks is avoided, and most of the usual auxiliary lines are unnecessary.

For most purposes the lines produced with the aid of the templet, if made with a sharp pencil, will be sufficiently good without any further work, but even where it is desired to sharpen up the drawing or to trace it in ink, the work will be greatly facilitated by the even height and spacing of the threads.

Too Big for a Lathe

(*Continued from page 82*)

expression was distinctly pained. He had called Old Bill out for service in time of need, and what did he hear—nonsense!

"I know," Old Bill replied evenly. "I noticed the lathes as we passed through the shop. I saw some other things, too—for instance, your milling machine, a couple of big boxes from some old engine, and a motor, and a speed changing outfit."

The mill foreman brightened. "Perhaps you can do it here after all," he conceded in a more conciliatory tone. "I hoped when we called for you that you would be able to figure out some kind of trick."

"I see what he is up to," exclaimed Lamons. "He is going to support the shaft in those bearings, and fix a tool to turn the journals."

"Why didn't we think of that before!" the mill foreman ejaculated. "Well, Old Bill has the reputation around here for devising ingenious methods, and I suppose we should not hope to equal him!"

They were still walking about one of the buildings. Old Bill, who had noticed some boards in the center of the concrete floor, pointed to them and asked, "What is under there?"

"Nothing now," the mill foreman replied. "There used to be a conveyor in a trench through this building, but now it is nothing but a covered pit."

"IT IS the very thing I have been looking for," Old Bill assured him. "*There* is the lathe where we will true up the shaft."

"The wheel will swing in the pit?" Lamons asked, much interested.

"Yes," Old Bill replied. "We will fix up these boxes so that they will carry the weight of the shaft and wheel. We will try to set them so that they are on some part of the shaft that is not worn."

"That will be all right on one end," Lamons commented, "but on the other there is nothing but the journal."

"Perhaps the journal on that end will be true enough to help some," Old Bill answered. "In case it is not, we will carry it on the centers."

"The centers?" Lamons queried. Then, quick to perceive Old Bill's thoughts, he added, "Oh, we will take the tailstocks from the lathes and bolt them to the floor?"

Old Bill gazed quizzically at the machinist. "You have it exactly," he admitted. "They will serve to take up all the end play, and then we may need them to carry the weight when turning the short end of the shaft."

"The speed reducer you mentioned—" Lamons went on, "I suppose we will use that to reduce from the motor, putting a belt over the big wheel?"

"Just so," Old Bill replied. "Then, we must have something to hold a tool, and I thought the best thing we could take would be the table from the milling machine. We can bolt the saddle to the floor, line up the table travel with the shaft, and clamp a turning tool to the top of the table. The feed will have to be by hand, for

(*Continued on page 112*)

Too Big for a Lathe

(Continued from page 111)

there is no use in trying to get a power feed for so short a job."

The mill foreman was beginning to absorb some of the spirit which animated Lamons, and he set off to get more men. When they arrived, Old Bill gave a few directions as to how to proceed and said, "I am going back to town now. Your men here have the idea well in mind, and will get it carried out, I am sure. I will come out tomorrow morning to see how they are getting along."

With that he went out to his car, feeling glad that he had come across a man who was capable of carrying out, yes, even anticipating, his thought.

The following morning he was on the job early. There were holes drilled in the floor. Some men had stayed all night to put them in. The machine parts were near by, and the boxes prepared.

"You wanted to pour the boxes against the shaft?" the machinist asked.

"Certainly," Old Bill replied. "I see you have the old metal out of them."

"The drive is just about fixed up, too," Lamons informed him. "I have figured the pulleys to run the shaft about forty feet a minute."

OLD BILL lingered a while, then went to the office to talk to the owners. He was interested to see how well the mill crew would get along without his guidance. They progressed very nicely, for a couple of hours later a man came in to say that the outfit was ready to go.

So Old Bill returned to the mill and saw the wheel in motion. He noticed that it ran perfectly true, which showed that the shaft was not bent. The machinist was adjusting the centers.

When he had the wheel revolving to suit him, Lamons stopped the shaft and again checked the alignment of the milling machine table. This he did by adjusting the tool at one end of the journal until his feeler gage would just fit in between the unworn part of the shaft and the point of the tool. Then he ran the tool to the other end of the journal and tried the feeler between the tool and the unworn portion at that end. It fitted just as well, which showed Lamons that the journal he was about to turn would be straight. Then he began the turning.

He was careful not to take off more than was necessary, and he gave particular attention to the honing of the tool in order to produce a smooth surface without having to file the bearing excessively.

The long end of the shaft was turned first. The milling machine table then was moved and lined up with the journal on the other end of the shaft. Here it was necessary to tighten up the centers so that they took the weight of the wheel. The box was left in place to catch the shaft should anything happen to the centers. That made it desirable to fit a scraper to keep the chips from being dragged down into the babbitt with the possibility that the finished surface would be scratched during the turning.

Old Bill looked on at the proceedings, giving a suggestion when called for, and, after a time, when the second journal was being turned, decided that he would go back to town.

"There is nothing else that I can do," he remarked. "About all I have done for you is to look up your own material so that you could do your job. I shall have to think a while for a name for this sort of service!"

"We have not been disappointed," the mill foreman assured him heartily. "We did not know how to get going, and you showed us."

"Well, that's really about what I do in my own shop," Old Bill returned. "There are two essentials to getting work out: the planning in advance, and the actual doing. I suppose that, after all, it is rarely one man can do both. My field seems to be the planning."

He drove back to town, pleased alike at the success of his scheme and the thought that sooner or later he might be able to add one exceedingly competent mechanic—Lamons by name—to his own shop forces.

Assembling Pipe Wrench with Aid of Paper Wad

How crumpled paper is inserted in a pipe wrench nut to hold the nut guards in place

IN ASSEMBLING the type of pipe wrench shown in the illustration, it is difficult to hold the nut in the frame, and at the same time keep the nut guards in place. A trick to make the guards behave is to put a wad of paper between them in the nut. When the jaw enters the nut, the wad of paper is pushed out.

Rubber Band Acts as "Keeper" for Set of Steel Numbers

SMALL steel punches for stamping numbers on metal are easily lost. To hold them in the usual wooden case, merely stretch a rubber band around the protruding ends, as shown.—FRANK W. BENTLEY, JR.

Punches are held in place by rubber band

BEFORE being babbitted, cast iron bearings should be heated to about 450 deg. F.

Controlling Searchlight from Motor Boat Cabin

A MOTOR boat searchlight can be controlled in rainy or cold weather without opening the pilot house window, if it is mounted as shown.

The standard is a piece of 1-in. pipe 5 ft. long with a T fitting at the upper end. A 10-in. length of pipe, an elbow, and another piece 8 in. long are added, and the light is clamped to the latter. A

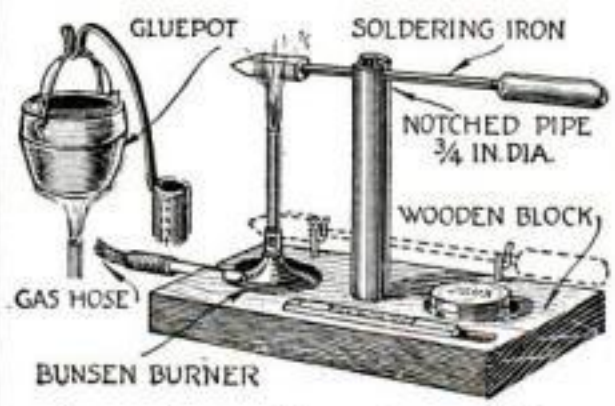
From within the pilot house this boat searchlight can be pointed in any direction

7-ft. length of ½-in. pipe runs upward through the 1-in. pipe and is connected to the light as indicated. As the lamp itself has a ball-and-socket connection on its clamps, it is possible to turn it to port or starboard by means of the 1-in. pipe, which is heavily taped inside the cabin to form a convenient grip. The ½-in. pipe is pushed up or pulled down to control the vertical movements of the lamp.—CARLTON GROAT.

Small Soldering and Glue Kit

SOLDERING iron and gluepot are household essentials. To keep them ready for instant service, I make use of the stand illustrated.

The pipe that supports the soldering iron or gluepot is screwed tightly into a hole in the center of the wooden base



A convenient and inexpensive stand for a Bunsen burner, soldering iron and gluepot

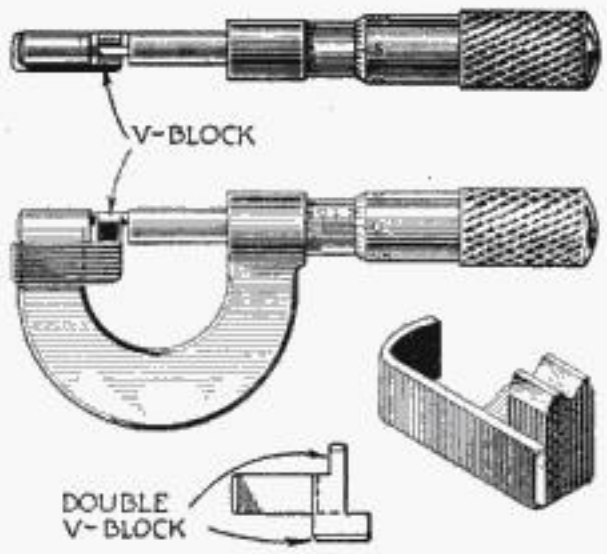
block. When the gluepot is to be used, a stiff wire, which is bent into a hook at one end, is thrust down to the bottom of the pipe. The gluepot is the smallest commercial size, but is large enough for ordinary purposes.—B. A. CHAMBERLIN.

TO MAKE a paint and varnish remover, mix ½ lb. melted paraffin wax, 1 gal. benzol, ½ gal. methyl acetone and ½ gal. denatured alcohol. Stir thoroughly.

V-Rest on Micrometer Holds Small Work

HOLDING small, slender work in a micrometer is a hard thing when the piece is so short and at the same time so thin that there is not room enough for the thumb and forefinger between the anvil and the spindle. If such work has to be measured continually, as when the product of a screw machine has to be checked, the task becomes one that is more than merely difficult—it becomes nerve racking. The V-rest illustrated was designed for just such cases and will be found to simplify the examining of such parts.

This little device consists of a small V-block with a sheet metal clip attached to it and designed to align the V-block just under and ahead of the anvil. The bent



Micrometer with V-block in place, detail of the fixture, and an alternative design

end of the clip is formed so as to adapt it to the outer surface of the micrometer frame. The V-block is notched out on the anvil side so that, when it touches the under edge of the anvil, the work will be near the top, where it can be easily placed. The surface of the lower part of the V-block, which comes in contact with the frame, is beveled off so as to form an angle of about 80 deg. to the clip, so that once the device is pushed on, it will stay in place. This construction also makes the V-rest automatically self-aligning.

The clip and block can be connected by soldering, or with small rivets or screws. The V-block may be made double, as shown in the small diagram; then merely by reversing it, a larger or smaller V may be brought into operation.

Any good tool should be hardened whenever possible, and it will pay to make both parts out of tool steel and heat-treat them, drawing the clip to a blue and the block to a light yellow.—H. S.

WIRE solder is useful in the shop for making patterns of irregularly shaped objects. In doing ornamental ironwork, for example, I do my experimenting with a length of wire solder instead of making a drawing. When I hit upon a satisfactory design, the solder is laid on a sheet of detail paper and the shape is traced; then the strip is straightened out and laid on the stock to mark the length of iron it is necessary to cut off for making that particular part.—T. M. BRIDGES.

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Sworn to and subscribed before me this 22nd day of March, 1927.

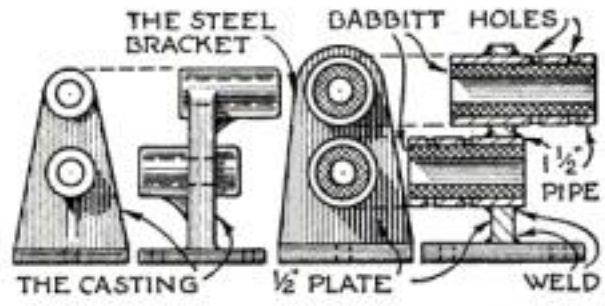
Bertha Strauss, Notary Public, New York County. New York County Clerk's No. 547, New York County Reg. No. 9195.

(Seal) My Commission expires March 30, 1929

Welded Steel Bracket Replaces Casting

IN AN industrial plant well away from shops and foundries there was a duplex steam pump to feed the boilers. A piece of pipe fell on it one day and shattered the valve gear bracket so badly that it was even beyond welding.

This did not stump the ingenious plant mechanic. He found two pieces of pipe and two pieces of half-inch plate and welded them together to make a part like



The original casting is shown at the left and the built-up welded bracket at the right

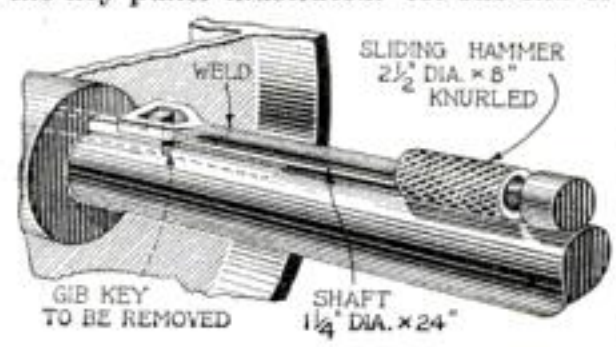
the broken casting. Then he drilled a number of holes through the pipes to anchor babbitt. Each of the pipes was filled with babbitt, and when cold the metal was expanded into the pipes by hammering.

To all intents he had a rough casting now. It was a simple matter to lay off the necessary holes and then drill them. The babbitt formed a wearing surface as good as the cast iron of the original, and the steel was amply stiff.

Tool with Sliding Hammer Removes Gib Head Keys

GIB head keys are much easier to remove than those without heads, provided one is able to drive against the head. However, when the key is in a webbed pulley or gear, there is no opportunity to drive them out in the usual manner.

To take care of such conditions we made the key puller illustrated. At one end of



A powerful key remover for gib head keys that cannot be driven out easily by sledging

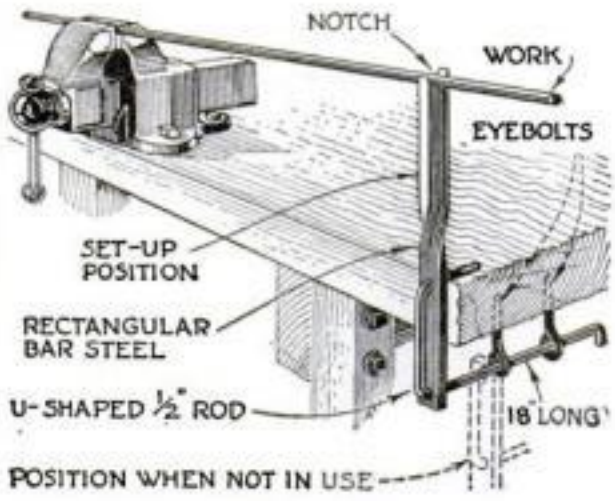
a bar an eye was forged that would fit over the gib head, while at the other end was a solid head. Sliding between, on the body of the bar, was a piece of shafting that served as a hammer. With the eye hooked over the head, the hammer was slid back and forth over the bar, striking the solid head, and quickly pulling out the key.—ANTON ZUPANCIC, JR.

TAPS, DRILLS and reamers can be reduced in size from .005 to .01 in. by immersing them in a solution of nitric and sulphuric acids. The amount of reduction depends upon the time they are left in the bath.

Auxiliary Support for Work Held in Vise

WHEN there is a long piece of work to be held in a vise, the machinist sometimes piles up boxes, pulleys, or anything at hand to support the end of it.

The accompanying illustration shows a support for such work that is always handy when wanted, but never in the way. It is arranged to swing down when not in use. The bar with the notch at its upper end is made of ⅜ by 2 in. flat stock twisted as shown. Two holes are drilled in it for the U-shaped ½-in. rod. One end of the bent rod rests on the top of the bench when the support is in the raised position and effectively locks it in place.



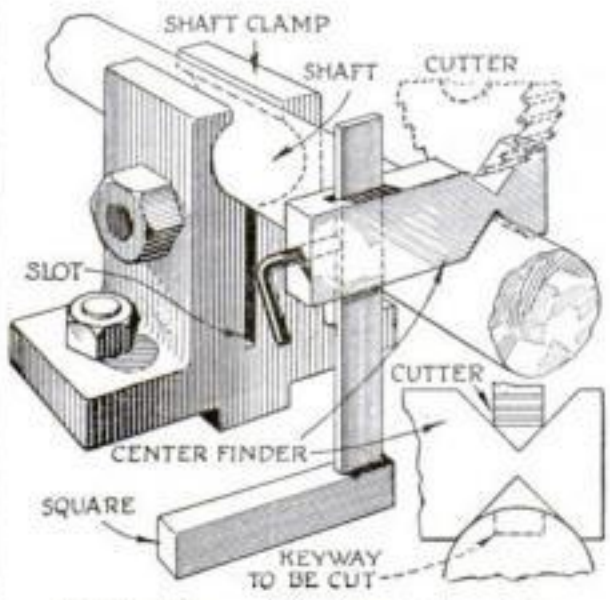
How the support, which disappears under the bench when not in use, steadies a long rod

The dotted lines show the support when lowered and pushed out of the way under the bench.—H. Moore.

Guide for Centering Key-Seat Cutters

By G. A. Luers

SETTING a key-seating cutter above the center of a shaft is tedious when the shaft is some odd diameter, and bothersome if the cutter is covered with oil, so a number of machinists make a practice of guessing at the location and letting it go at that. If they have not guessed well enough, the key-seat will be off center, and will not match perfectly with the key-seat in the hub. The key cannot be well fitted in such a case, and is likely to cause trouble, especially where the drive runs first one way and then the other.



A V-block for centering key-seating cutters accurately, and a fixture for holding shafts

To obviate this trouble and at the same time to expedite the work, one enterprising machinist made up a double V like that shown in the accompanying illustration. This V was made to fit the blade of his try-square, and in use was rested on the shaft. Then the cutter was lined up with the upper V. By this procedure he was sure that the milling cutter was directly above the center of the shaft and that he would have an accurate key-seat.

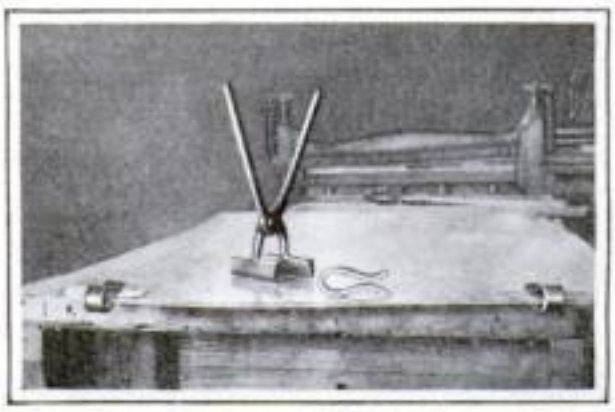
The illustration also shows a fixture for holding shafts for keyseating that is a departure from the usual custom. It has been found more satisfactory than V-blocks, particularly where there are a number of shafts of the same size to be keyseated, as in machine building plants. It is made of cast iron with a hole bored to receive the shaft. A tongue on the bottom fits the T-slot in the milling machine table. Bolts are provided to secure the block to the table, and there is another bolt to clamp the shaft being keyseated. The spring of the casting releases the shaft when the clamp bolt is loosened.

The clamp can be made for any size shaft, and it is possible to have split bushings to adapt it for use with smaller shafts.

Bending Tongs and Spring Clamps for Tin Shop

TWO simple devices are illustrated that have proved extremely useful in a Denver tin shop.

The first is a pair of rivet heater's tongs with wide jaws. These are 4-in. strips of ½ by 1 in. iron ground to an edge from the outer sides and welded on each jaw of the tongs. The tool is handy for bending light sheet metal.



Rivet heater's tongs with wide jaws welded to them for bending tin; a set of spring clamps

The other is a clamp that may be slipped quickly over sheets of metal, clothespin fashion, pinning them firmly to the work bench. A set of these is made of spring steel, about 6 in. long and ½ in. thick. The one shown on top of the bench illustrates the shape.—Joseph C. Coyle.

Cutting Pulley Oil Grooves

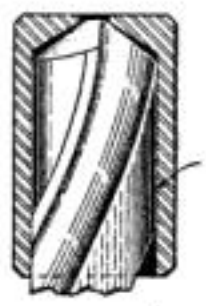
INSTEAD of chipping oil grooves in pulleys or bushings, they can be cut by putting a properly shaped tool in a boring tool holder and working the lathe carriage back and forth by hand while the pulley is stationary.

Simple Center Gage for Drill Points

IN SHARPENING drills, the key to the situation is to keep the point central and of proper width. A drill with a correctly formed, central point is rarely out in any other way, because such a point is difficult to produce except by correct grinding. On the other hand, no drill will do good work or stand up as it should if the point is off center to any appreciable extent.

The importance of this is recognized by every good mechanic, and various methods are in use to find out when the point is central, and if not, how much it is out. There is the simple way of measuring both cutting edges with a scale, but that is too troublesome when it has to be repeated many times, and besides is good only for the larger drills. Gages based upon this idea are convenient, but sometimes fail when used on slender drills which have become slightly sprung.

By means of the very simple type of gage shown in Fig. 1, the location of the



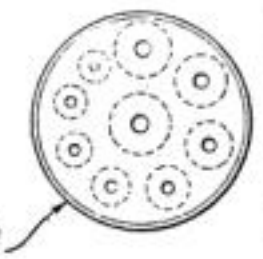


FIG. 1 FIG. 2

The gages are made single for large drills (Fig. 1) and multiple for small drills (Fig. 2)

point and its deviation in any way is established infallibly in a moment's time. This gage consists of a steel or brass cup bored out to the size of the drill it is to test. A hole slightly larger than the width of the drill point is formed in the end. The inside of the cup is counterbored at an included angle of about 125 deg., so as to bring the point of the drill always in contact with the bottom of the small hole. The end of the cup should be faced off to leave a wall thickness of from $\frac{1}{32}$ in. for larger drills to about $\frac{1}{64}$ in. for smaller ones. The inspection end of the gage should be blackened or blued so that the bright drill point will show up plainly.

All that is necessary to examine the point is to push the drill into the gage and look at the end. There is no need to revolve the drill, as any error will be instantly visible.

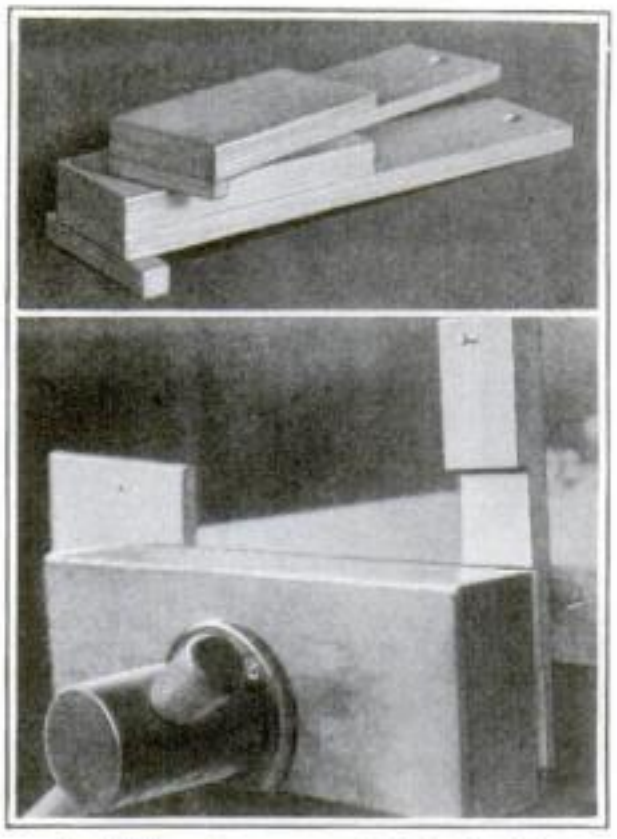
For smaller drills, say under $\frac{5}{8}$ in., combination gages accommodating from three to fifteen drills can be made as shown in Fig. 2 from a piece of $1\frac{3}{4}$ in. round stock, so that the entire range of sizes from $\frac{3}{16}$ to $\frac{5}{8}$ in. can be accommodated on three or four small plates. The length of the gage should be not less than twice the diameter of the largest drill it is to test. It is not practical to make gages for drills smaller than $\frac{3}{16}$ in.

Compensating Blocks for Wooden Bench Vise

By Charles M. Miller

BENCHES in many home workshops and in the majority of manual training shops are fitted with wooden vises of either the cabinetmaker's or carpenter's type. When a board is clamped at one end of a wooden vise, the jaw usually is twisted out of parallel with the bench top. This is bad alike for the vise and for the work, and in time the vise may split and become so loose that it will not operate satisfactorily.

By inserting a block of the same thickness as the work in the opposite end of the vise, the strain becomes equalized. It is a simple enough matter to keep on hand



A set of two vise compensating blocks of the built-up type, and a one-piece block in use

suitable blocks of the more common thicknesses of dressed boards. Still more convenient are the blocks shown above.

Blocks such as those in the upper illustration will serve most purposes. One is made of a piece ¼ by 2 by 8½ in., a piece ¼ by 2 by 4½ in., and a strip ¼ by ¼ by 2 in.; the other consists of a piece ⅜ by 1¾ by 8½ in., a piece ½ by 1¾ by 4½ in., and a strip ⅜ by ⅜ by 2½ in.

The reason the cleat for the second block is made 2½ in. long is so that the ends will project enough to prevent the block from sliding down through the vise when it is used edgewise to compensate for work 1¾ in. thick.

Another type of block made of solid stock is shown in the lower illustration. It has a projecting screw to prevent slipping when the thickest section is in use.

Redwood for Ship Model Making

FOR making blocks and deadeyes for ship models, I have found that redwood is easily worked and does not split readily. Strips cut from an old T-square were utilized for this purpose in my own case. The wood is of such a color that no varnish or paint is necessary. —E. A. D'Armer.

We Pay for Ingenious Shop Short Cuts

WHENEVER you work out some way of doing a job that is a little quicker or easier than usual, remember that you can, perhaps, turn the idea into cash by sending it to the Better Shop Methods Department of Popular Science Monthly, 250 Fourth Avenue, New York. You will be helping other mechanics by passing on your labor-saving "kinks," and at the same time may earn some extra money.

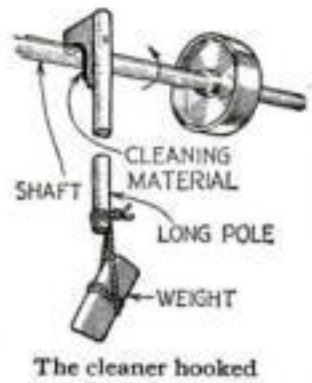
Make a rough sketch to show what you have accomplished and write out a brief description. You may write with pencil, if you wish; it's the idea that counts, not the form. Have a photograph taken, if possible, showing just how you did the work or what the tool, fixture, machine or product looks like.

If your suggestion is one that can be published in this department, a check will be sent you promptly, the amount depending upon the originality and utility of the idea rather than the length of the description.

Cleaning Device Keeps Shafting Polished

EVERY mechanic takes pride in a shop that is clean and free from rubbish. He likes to have his tools on his workbench while in daily use or in the tool box if needed on but few occasions.

While keeping the shop clean, do not forget the shafting above. In a week's running, the shaft will gather a great deal of flying dust or shavings. This dirt can be removed easily if the shafting is cleaned once a week, say every Saturday morning.



The cleaner hooked over the line shaft

A rod of wood of convenient length serves as the handle of the device. This strip should come within a few feet of the floor when in use. At the top end is nailed a short block shaped as shown on the inside edge to fit over the shaft. Strips of abrasive are fastened to the inside of the block.

The device is hooked over the shaft and a weight fastened to the end of the pole. This pulls with sufficient force to wipe off all the dust and tarnish. After one section is cleaned, move the cleaner to the opposite side of the next pulley to clean and polish a new part of the shaft. —H. E. Wenrich.

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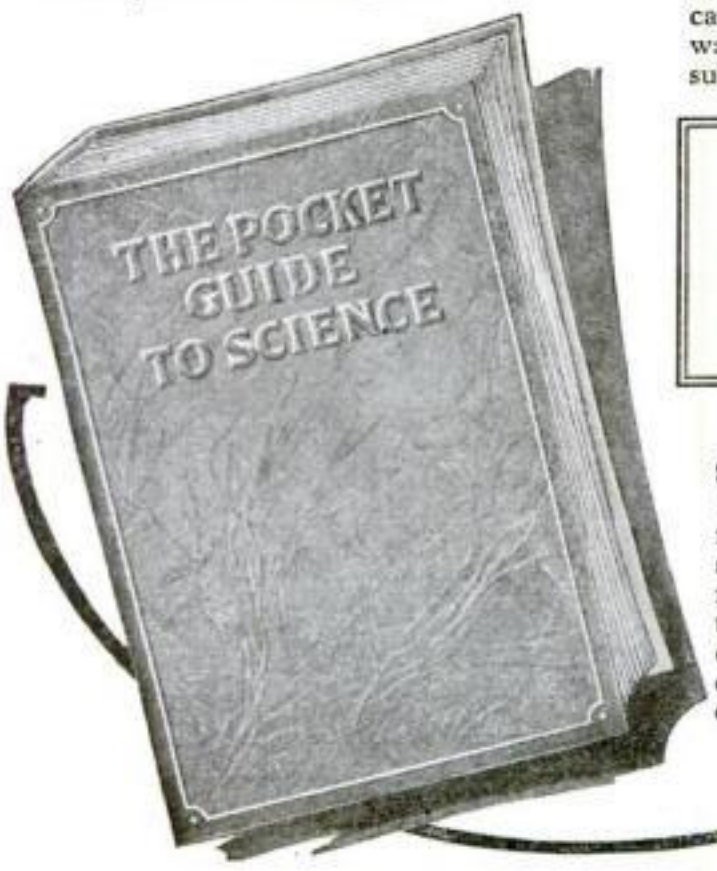

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Joseph Falk, New Brunswick, N. J.
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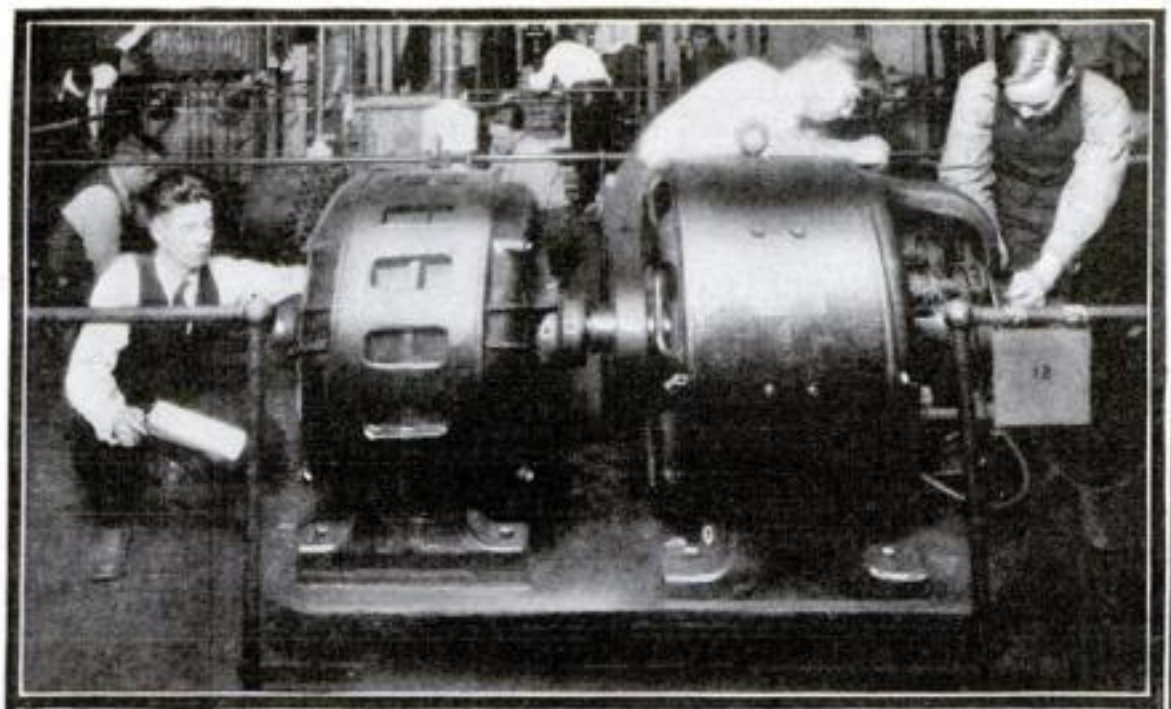

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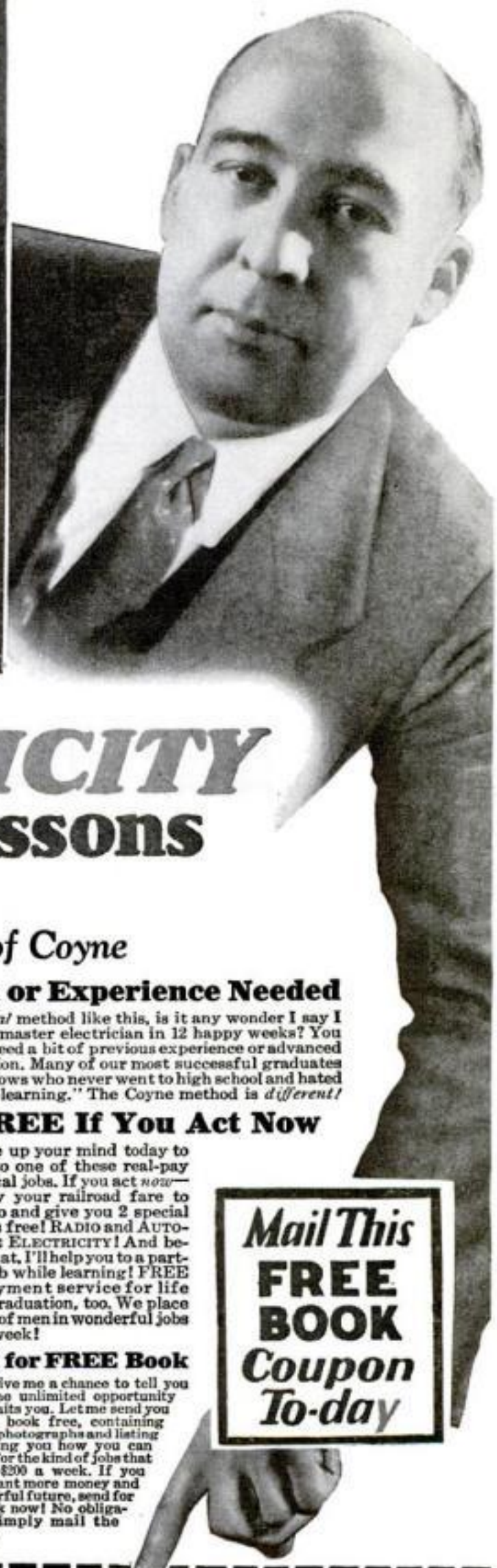

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BANKRUPT and Rummage Sales. Make $50.00 daily. We start you, furnishing everything. Distributors Dept. 34, 699 Division, Chicago.

$10 DAILY silvering mirrors, plating and refinishing lamps, reflectors, autos, beds, chandeliers by new method. Outfits furnished. Write Gunmetal Co., Ave. F, Decatur, Illinois.

AGENTS—Best seller; Jem Rubber Repair for tires and tubes; supersedes vulcanization at a saving of over 800 per cent; put it on cold, it vulcanizes itself in two minutes, and is guaranteed to last the life of the tire or tube; sells to every auto owner and accessory dealer. For particulars how to make big money and free sample, address Amazon Rubber Co., 504 Amazon Building, Philadelphia, Pennsylvania.

BIG money and fast sales. Every owner buys gold initials for his auto. You charge $1.50; make $1.35. Ten orders daily easy. Write for particulars and free samples. American Monogram Co., Dept. 47, East Orange, New Jersey.

A BUSINESS of your own—Making Sparkling Glass Name and Number Plates, Checkerboards, Signs. Big Book and Sample free. E. Palmer, 513, Wooster, Ohio.

AGENTS—Make a dollar an hour. Sell Mendets, a patent patch for instantly mending leaks in all utensils. Sample package free. Collette Mfg. Co., Dept. 467, Amsterdam, N. Y.

Salesmen and Agents Wanted

EARN $10 daily silvering mirrors, plating and refinishing metal ware, headlights, chandeliers, bedsteads. Outfits furnished. F. Decie Laboratories, 1133 Broadway, New York.

POLMET Polishing Cloth cleans all metal. Sells fast at 25c. Sample free. F. C. Gale, 15 Edinboro St., Boston.

AGENTS—new plan, makes it easy to earn $50.00 to $100.00 weekly, selling shirts direct to wearer. No capital or experience needed. Represent a real manufacturer. Write now for free samples. Madison Company, 566 Broadway, New York.

ANY salesman can sell them! Merchants everywhere use punchboards. Someone sells them, why not you? Collect big commissions daily. Newest, largest elaborate catalog sent upon request. Lincoln Sales Co., 9 S. Clinton, Chicago, Dept. G.

AGENTS: Make $500.00 Monthly. Pay daily. No investment. Rhinestone initial buckles and novelties. Sell easy everywhere. Exclusive territory. Chaton Novelty Co., 606 Blue Island, Chicago.

AGENTS—greater profits, year round sales; complete guaranteed line dress and work shirts, overalls, coveralls, work pants, playsuits. $10-$25 daily easy. We show you. Complete Outfit Free. Nimrod Shirt Co., Dept. 25, 4922-28 Lincoln Av., Chicago.

DON'T sell for others. Employ agents yourself. Make your own products. Toilet articles, household specialties, etc. 500% profit. We furnish everything and show you how. Valuable booklet free. Write at once. National Scientific Laboratories, 1962 W. Broad, Richmond, Va.

AGENTS, both sexes, we manufacture and control new household article. Fast seller. Big profits. Exclusive territory. Write now, Connolly, 123 Liberty St., N. Y.

AGENTS, Salesmen, Crewmen—You'll have the Devil's own time finding a better seller than "Zippo." Splendid profit on snappy 50c "Go-Getter" repeat article that sells on a ten-second demonstration. Works while you watch it. Demonstrates value while others waste time making claims. New development. Greatest scientific triumph of the age. It's the berries. Write immediately for complete proposition. Karam-Smith Company, 906 Bozan Street, Fort Wayne, Indiana.

MR. ADVERTISER: Ask today for a copy of the "Quick-Action Advertising Rate Folder." It contains some really important facts which will prove interesting and valuable to you. It also tells "How You Can Use Popular Science Monthly Profitably." You'd like to know, wouldn't you? Address your inquiry to: Manager, Classified Advertising, Popular Science Monthly, 250 Fourth Ave., New York.

SELL Beauty Aids, New Plan, sample and particulars 25c. Jeanne, 244 Sta. A, San Antonio, Texas.

AMAZING Gas Saver. Every Auto. 1 free to introduce. Vapor moisture. Doubles Mileage. Critchlow, A-142, Wheaton, Ill.

$75 WEEKLY. Man or woman wanted with ambition and industry, to distribute Rawleigh's Household Products to steady users. Fine openings near you. We train and help you so you can make up to $100 a week or more. No experience necessary. Pleasant, profitable, dignified work. Write to-day. W. T. Rawleigh Co., Dept. NY9953, Freeport, Ill.

FREE: Large wholesale specialty catalog, showing best sellers from all parts of the world. Sporja Co., Lesueur Center, Minn.

$75.00 WEEKLY to introduce "Chieftain" 3 for $4.95 Guaranteed Tailored Shirts. Full working outfit free. Your own shirts free. Cincinnati Shirt Company, Lane 1606, Cincinnati, Ohio.

MAGIC Polishing Cloth—great seller—big profit. Try this cloth—it's a money-maker. Full size sample free. Get this proposition. Newton Co., 171 Main St., Newark, New York.

Salesmen and Agents Wanted

AGENTS Key Check Outfits. Sample Check Stamped with Name and Address 15c. Catalogue free. E. Jewell (Novelty Works), Shelby, Ohio.

'RITHMETIC Kid makes Quick Money. Sample and Wholesale prices 25c. Wholesale Supply Co., Valdosta, Ga.

NEW Camera. Regular black and white photos finished quickly inside camera. Make money selling cameras, taking photos or doing both. Crown Company, Dept. 485, Norwalk, Conn.

$50.00 WEEKLY easy, Applying Gold Initials on Automobiles. No experience needed. $1.45 profit every $1.50 job. Free samples. "Raico Monograms," 1041 Washington, Boston, Mass.

STATE Manager. Marvelous patented envelope Sealer. Seals 2,500 Envelopes hour! Retails $4.50. Large profits! Tremendous market! Exclusive territory. Consolidated, 25AC Huntington, Boston, Mass.

35% COMMISSION selling $1.50 boxes Monogram Stationery. New. Write. Wolfeprint, Lawndale, Philadelphia.

MULTEX The Automatic Card Index Wants Commission salesmen. Address Multex, Sta. E, Box 29, Atlanta, Ga.

SELL absolute necessities. Cost 2c sells 25c. Prices lowest. Seven different samples 30c. Catalog free. Mills Sales Co., 13 East 16th St., New York.

TOOL Salesmen—Mechanics—Distribute guaranteed line auto repair tools. Exclusive business of your own. Show 71 samples in case. Big commissions. Quality Tools Corporation, New Wilmington, Pa.

SALESMEN to sell a necessity for every store, jobber and factory. Commissions immediately. Good opportunity to build permanent business $3500 to $6000 annually. Write Ed. Kessler, Manager, Dayton, Ohio.

10 EASY sales daily, profit $1,000 month! Amazing vaporizer practically doubles gasoline mileage! Tests show 63% increase! Exhaustively tested by Carnegie Institute Technology! Sensational seller! Territory! K. Phills Mfg., St. Louis.

CALIFORNIA perfumed beads selling like hot cakes. Agents coining money. Big profits. Catalog free. Mission Factory, R2328 W. Pico, Los Angeles, Calif.

SELL "Fixit" Rubber Repair. Big pay. Doubles mileage of tires and tubes. Self-vulcanization without heat or tools. Big season now. Marquette, AA2323 Wolfram, Chicago.

HOSIERY Free and $12 daily. Sell nationally known Pure Silk hosiery. Amazing values. Experience unnecessary. Free sample outfit mailed immediately. Pure Silk Hosiery Co., 208 W. Monroe, Dept. P-63, Chicago.

ACTIVE men to distribute repeating 5c candy specialties to dealers and jobbers. Full co-operation. Universal Sales Company, 631 R Wilson Ave., Brooklyn, N. Y.

SALESMEN—If you want to get into a real money-making business, and help others at the same time, sell Radium Health products. Exclusive territory. $6.50 profit every sale. Write Radiumized Applicator Company, 1303-W Fillmore, Buffalo, N. Y.

IF YOU can devote spare time to profitable work that pays $2.00 to $4.00 an hour, write us at once. No experience necessary. Nawco Company, Dept. 6-D, Covington, Ky.

FREE outfit—$10-$15 daily. Guaranteed all-wool tailored trousers less than store prices. Quick sales. Big money. Pay daily. Free trousers offer. Hutchins Pants Co., Dept. 190-FC, Cincinnati, Ohio.

SIMPLEX Vaporizer. 25 to 60% increased mileage guaranteed. Retails $1. Thirty days free trial. Exclusive territory. American Fixture Co., 232 West Water, Milwaukee, Wis.

AGENTS $240 month. Bonus besides. New auto given. Introduce finest line silk new hosiery, guaranteed six months. 126 styles, colors. High class proposition. New sales plan. No license to pay. Spare time satisfactory. Samples furnished. Write quick. Wilknit Hosiery Co., Dept. 1432, Greenfield, Ohio.

YOU are wanted to resilver mirrors at home. Immense profits plating autoparts, tableware, etc., write for information. Sprinkle, Plater, 96, Marion, Indiana.

AGENTS: 90c an hour to advertise and distribute samples to consumers. Write quick for territory and particulars. American Products Company, 9215 Monmouth, Cincinnati, Ohio.

SUCCEED making your own products. Use our formulas, processes. All kinds. All lines. Catalog, special circulars free. C. Thaxly Co., Washington, D. C.

$15.00 DAILY (In Advance) introducing latest guaranteed hosiery for men—women—children. Just write orders. We deliver and collect. Capital—experience unnecessary. Samples furnished. Milton Mathews, Road 1526, Cincinnati, Ohio.

SALESMEN—Get free outfit and make $90 a week taking orders for famous Taylor rain-proof, made-to-measure caps and knickers for men. Also eight other big profit-makers. Commission in advance. We deliver. Taylor Cap Manufacturers, Desk U-3, Cincinnati, Ohio.

NEW Cigar and Cigarette Lighter sells for $1.00. Does work of $20.00 lighters. Your profit 100% in advance. Every lighter guaranteed 10 years. Amazing profit maker. Sale a minute. New Plan. Write for sample offer and details. Masterlite Company, Desk 601, 110 East 23rd Street, New York City.

EASY Money wearing free shirts. Be my local distributor. Greatest values ever offered. Big Profits. Fashion Wear Shirt Co., Dept. G-362, 1220 Jackson St., Cincinnati, Ohio.

NOTHING Sells Like Shoes. Every person a prospect. Take orders for Mason Shoes direct from factory. 85 stunning styles. Amazingly low prices. No experience needed. FREE outfit. Mason Shoe Mfg. Co., Dept. 45, Chippewa Falls, Wis.

I WANT a partner—agent to take care of my business in your town. I furnish everything, including world's finest line of 175 household products and I split the selling price with you 50-50. Beautiful sample outfit makes selling easy; food products; household necessities; things people eat; highest quality—lowest prices—quick sales—permanent repeat business; $25,000 bond guarantees quality. I pay largest commissions—give Chrysler closed car besides. Get my amazing offer for your locality quick. Write or wire C. W. Van De Mark, Vice Pres., Health-O Products Co., 41-F Health-O Bldg., 117 Duane St., Cincinnati, O.

Salesmen and Agents Wanted

MISTER Agent let me tell you how to make the World's Biggest-selling Specialties as, Sealatite, puncture-proofing liquid for tires; Solvit Hand Cleaner; Mendit, Fabric Patching Liquid; Cellu-lac Automobile Finish—all colors; Bugacide, Fly-killing Spray; Non-Thermic Ice Saving Cloth; Tufnit, for quadrupling life of Silk Hosiery; Ducopol Guaranteed Most Efficient Automobile Polish. Fifty other equally Big Money-Makers. Investment Small. Profits Great! Let me tell you how to get the profit you're entitled to. Miller, Industrial Chemist, Miller Chemical Building, Tampa, Florida.

AGENTS: Build a permanently profitable business on one easily sold item. Globe Re-Atomizers, a new, patented invention has an untouched, ten-million dollar market awaiting it. Act now and obtain exclusive representation. Send $1.00 for sample and complete information. References: Chamber of Commerce, R. G. Dun, National City Bank, Brotherhood Bank. Globe Sales & Distributing Co., 101A Spokane St., Seattle, Wash.

SELL Radium Water Generators. Entirely new fast seller, repeat orders sure. Permanent income. Ask Why today. Radium Refinery, 2209 Broadway, Oakland, Calif.

Seeds

PALM Trees. Grow them from seed. Large package of seed and instructions, 25c coin. Guaranteed to grow. A. Buffington, 711 N. 3rd Street, Phoenix, Arizona.

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EVERYTHING for battery and tire shops at wholesale prices. Send for interesting complete catalog. Adams-Barrs, Columbus, Ohio.

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STAMPS, 100. All different, 3 cents. Lists free. P. S. Quaker Stamp Co., Toledo, Ohio.

STAMPS Free—Ask for money-saving approvals. John K. Borresen, Cedar Falls, Iowa.

STAMP Collectors—Phillips Monthly Bulletin (illustrated) offers over 2000 special bargains, sets, packets, etc. each issue. Free. Phillips, Box 1012, Hartford, Conn.

OLD coins, large Fall selling catalogue of coins for sale free. Catalogue quoting prices paid for coins, ten cents. William Hesslein, 101B Tremont Street, Boston, Mass.

CALIFORNIA gold $\frac{1}{4}$ size, 27c.; $\frac{1}{2}$ size, 53c. White cent and catalogue, 10c. Norman Schultz, Box 746, Salt Lake City, Utah.

150 GOOD mixed foreign stamps, 3c. Stanton (144), Niantic, Conn.

50 DIFFERENT Portugal Colonies, 10c; 200 different world, 10c. Louis Morrison, Glenolden, Pa.

20 VARIETIES unused free. Postage 2c. P. S. Miami Stamp Co., Toledo, O.

500 GOOD mixed stamps, bargain lists, magazine, catalog, packet hinges, all 25c. Approvals for beginners. Harvey Teeple, Decatur, Indiana.

50 DIFFERENT South American $.25; 100, $.50; 200, $1.50; 300, $3.00. Fred Onken, 630 79th Street, Brooklyn.

300—300—300. ALL different stamps (cat. over $6.00); 300 hinges; 5 approval sheets; duplicate stamp album; perforation gauge; millimeter scale and ruler to approval applicants only for 20c. Edgewood Stamp Co., Dept. S., Milford, Conn.

40 OLD coins all different $1.00. Lexington Concord Half-Dollar Unc. $1.10. 300 different Germany City Lots $1.00. M. Denney, Box 315, Dallas, Texas.

Stories Wanted

STORY Ideas Wanted for photoplays, magazines. Big demand. Accepted any form for revision, development and submission to markets. Estab. 1917. Send manuscripts for free criticism. Booklet mailed on request. Universal Scenario Company, 402 Western & Santa Monica Bldg., Hollywood, Calif.

CHICAGO Technical College offers short, intensely practical courses in Drafting and Engineering—civil, mechanical, electrical, structural—Architecture, Building Construction, Plan Reading, etc. Courses fitted to your needs. No time wasted. Instructors are experts. Graduates in demand at big salaries. Opportunities for part-time work while studying. Day and evening classes. 24th year. Enter any time. No special preliminary training required. Low tuition—easy terms. Write for 72 page illustrated Blue Book, describing opportunities open to our graduates. Chicago Technical College, 23 Chicago Tech. Building, Chicago.

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LEARN bricklaying and earn $1 to $1.75 an hour. Wm. M. Woods, who has trained 500 men will teach you bricklaying in our school run by 800 builders interested in giving jobs to Mr. Woods' students. Tuition $60.00 per month. Time required, 3 to 6 months. Board and room, $8.00 to $10.00. Work is actual bricklaying; you become a master in the craft, in line for highest wages and promotion. Ample space and material. Catalog free. Associated Building Employers, A. B. E. F-500 Building, Grand Rapids, Michigan.

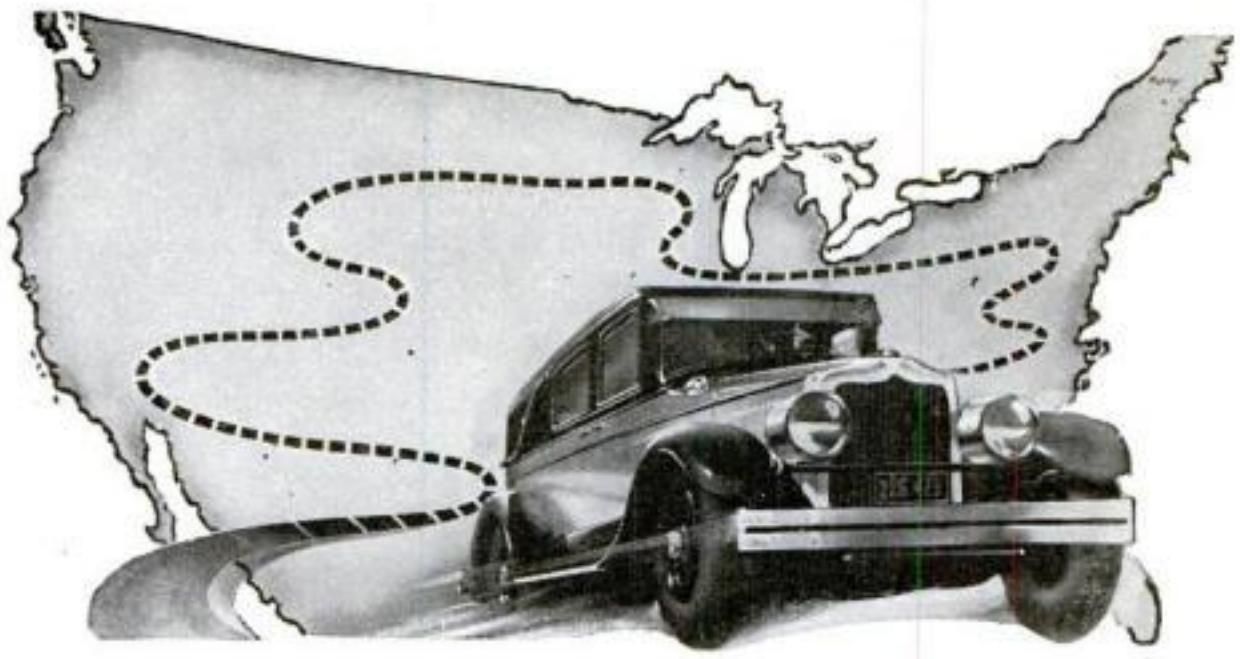
Typewriters and Supplies

TYPEWRITERS: all makes; lowest prices; 5 year guarantee; send for illustrated catalogue. Henry Typewriter Co., 217 West 125 Street, New York, N. Y.

"RENT a typewriter." Any make. If you pay its price in rent, we give machine free. Catalog free. Pgh. Typewriter Supply, Suite 543, 339 Fifth Ave., Pittsburgh, Pa.

Wanted

DETECTIVES needed everywhere. Experience unnecessary. Particulars free. Write, American Detective System, 2190-P Broadway, N. Y.



10,000 Free Miles of Gasoline!

On a 3,000 mile trip, J. R. Wood reports that his Oldsmobile ran 30 miles per gallon where before he got only 17 miles—due to an amazing device now used by over a million car owners! At this rate, if his car lasts 23,000 miles he will get 10,000 free miles of gasoline. Write the inventor now to test the device on your car at his risk.

$75 to $200 in a Week

OVER a million Stranskys have been installed on practically every make of automobile, also on trucks, tractors, stationary engines, marine engines and aeroplanes. Many of them after three to eight years of constant practical tests report increased mileage, more power, less carbon and no spark plug trouble. Seldom has such an invention so taken America by storm. No wonder Williams made $48 in three hours and Foster $137.50 in a week!

$48 IN 3 HOURS

My gas bill has been cut in half. I have removed every particle of carbon from my engine. Since I installed it, my engine runs as good as new, starts easier and quicker. I went out Saturday about three hours and secured 16 orders.—J. A. Williams.

HOW IT WORKS

J. A. Stransky, former candidate for Governor of South Dakota, is the inventor of this device. It is a simple little piece not much larger than a dollar coin and a 12 year old boy can install it. It is automatic and self-regulating. It operates on a universally-recognized engineering principle that has been approved, after exhaustive tests, by experienced auto drivers, automobile dealers, and expert mechanics.

Official tests have proved that most cars waste 30% of the gasoline power through improper combustion, and we have thousands of unsolicited testimonials like the following: Ford, 20 to 40 miles on a gallon, Star, 25 to 42, Chevrolet, 30 to 43, Hudson, 19 to 21, Overland, 19 to 31, Nash, 19 to 22, Hupmobile, 32 to 37, Buick, 18 to 32, Studebaker, 23 to 27, Cadillac, 12 to 18—and so on. Are **you** getting that many miles per gallon now?

The STRANSKY VAPORIZER
Saves Gasoline
Dept. G-730, Pukwana, S. Dak.
Resources $500,000.00

GOOD-BYE CARBON

Not the least remarkable news from car owners is that this amazing device has banished carbon and spark plug trouble. Naturally when gas is more thoroughly vaporized raw gasoline cannot enter the cylinders to score and pit—a constant menace to every car. Furthermore, this device permits a new easy way to remove carbon already formed; the same cleansing principle as used on the famous Diesel engine.

DARING TEST OFFER

Mail the coupon now for free test offer. The inventor will pay a cash forfeit if the test fails to save gas. Ambitious men—speak up! $75 to $200 in a week is a fair expectation as our distributor. Other men have earned at this rate, full and spare time. Every car owner wants to see this nationally advertised proposition; we give you exact plan to follow that can net you $75 to $200 in a week. The coupon brings you full details without obligation. Act now.

FREE COUPON

L. G. Stransky, General Manager,
J. A. Stransky Mfg. Co.,
Dept. G-730, Pukwana, So. Dakota

Yes, tell me how I can test this way to save my gasoline—at your risk. Also send me your money-making distributor's plan. This request does not obligate me to order anything at any time.

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Child's Desk Built into a Chair

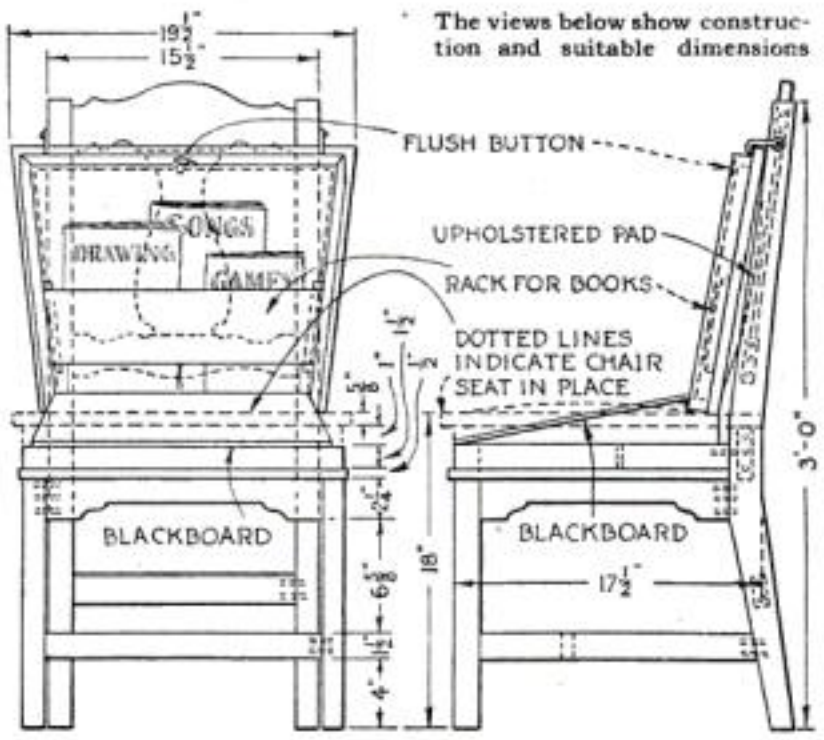
A Space Saving Toy for Small Homes

By CHARLES A. KING

CHILDREN enjoy drawing pictures and "playing school," as they describe it. When they begin to go to school they do cheerfully a surprising amount of home study. It pays well, therefore, to provide a convenient desk for them. The one illustrated is in the form of a combination desk and chair and is designed especially for use in an apartment or small house in which there is little room for a child's belongings.

When the seat is lifted, a blackboard made of 3-ply wood is brought in view. This may be used in a nearly upright position or slanted like a desk. There is also a rack for papers and drawing books, which is concealed by the blackboard when in its upright position. In the lower part of the seat are various compartments for writing materials, games, and the like.

Novel chair-desk for the child who likes to draw



While the design calls for the shaping of the back rails and splat, it may be simplified by making three rails in the back; these will be more comfortable if given a horizontal curve of about 1 inch. Hooks are placed at the top to hold the seat when it is raised.

The chair may be made of oak, ash, red birch or other strong wood, and the seat upholstered with a felt filled pad after the finishing has been done.

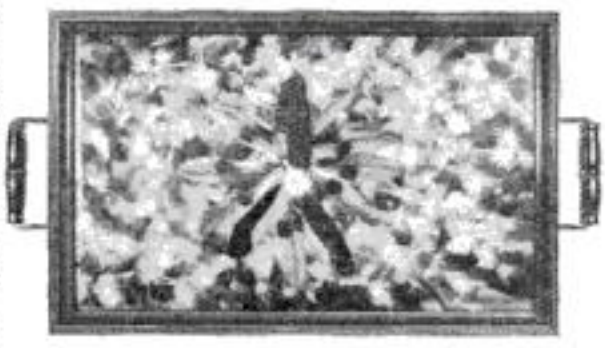
The desk compartment obviously can be fitted into an old chair of suitable design and solidity at a considerable saving of work.

Parrot Feathers Decorate Unique Serving Tray

A BRILLIANT, colorful "feather mosaic" forms the striking decoration of the serving tray illustrated. It can be duplicated by anyone who has a parrot or is able to obtain a variety of bright hued feathers.

In this case the feathers were moulted by a small yellow-headed Mexican bird. When a sufficient supply had been obtained, the plywood back was removed from a mahogany serving tray and covered with a thin sheet of light gray cardboard, which was fastened with tiny flat-headed tacks at the corners. The feathers were roughly assorted by their general tints and then arranged on the cardboard.

The carefuly cleaned glass was lowered on the feathers and the frame was put in position. A thin blade was slipped beneath the backing and the whole tray raised carefully and laid face down over a box, so that the handles could not touch the table. The back was fastened in place and covered with slightly damp wrapping paper, which stretched as tight as a drumhead when it had been glued by its edges to the frame of the tray.—CHARLES M. DOTEN.



A gorgeously colored "feather mosaic." The central feathers are blue-black, green and red; the others are gray, scarlet, yellow and white

PATENTS

At the right is a view of my drafting and specification offices where a large staff of experienced experts are in my constant employ.

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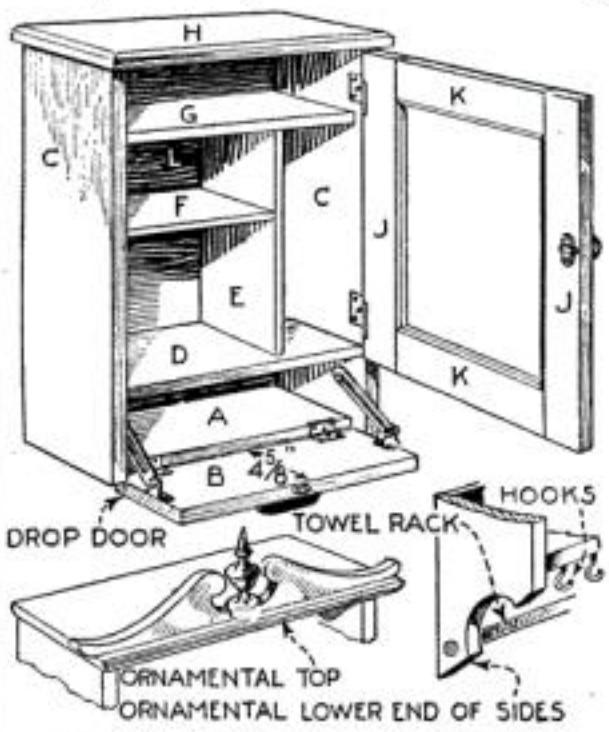
Wall Cabinet Has Handy Shaving Shelf

By H. A. Bailey

WE MEN—and boys too—who make things for our home generally get less use out of such articles than do the other members of the household. Here's a project, however, that will please everyone. It is a bathroom medicine cabinet with a special shaving outfit compartment that has a drop-door shelf. This door gives ready access to the shaving articles without interfering with the use of the mirror in the large door above it.

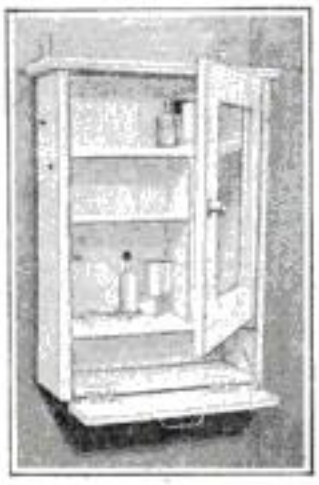


Shaving articles on the lowest shelf can be reached without opening the mirror door

The interior of the cabinet is arranged for packages and bottles of various sorts and sizes.

No trouble will be encountered in building the cabinet if the sides, top, bottom and shelves are cut accurately to the sizes indicated in the accompanying bill of materials.

Dadoes (grooves) are cut in the sides C ¼ in. deep to take the shelves D and G. The dadoes are stopped 1 in. from where the front edges of the shelves are to come and the shelves themselves are notched out to suit. The shelf F also is housed ¼ in. deep in side C. The sides, top and bottom are rabbeted ⅜ by ⅜ in. to receive the back, which may be wallboard, plywood or any thin material.



A medicine cabinet of unusual utility

The mirror door should be so made that the space rabbeted out for the mirror will be 11¼ by 14⅞ in., although the glass itself will be slightly smaller than this. The door may be made with mortise and tenon joints or doweled together, or even constructed with mitered corners such as are used in an ordinary picture frame.

The side pieces may be extended for some distance below the bottom shelf, if it is desired to ornament the cabinet, and a curve sawed out either with a coping saw or a band saw, if one is available. This extension makes it possible to add a towel bar and toothbrush hooks. The top also may be ornamented in some such way as suggested at the bottom of the accompanying drawing.

As the cabinet is intended to be finished either with two coats of flat white paint and one or two coats of white enamel, or two coats of shellac and two or three coats of white brushing lacquer, it is possible to use any close grained wood such as poplar, white pine or whitewood.

Bill of Materials

Parts	Pieces	T.	W.	L.
A. Bottom	1	¾	4⅞	15
B. Drop door	1	¾	4⅝	15
C. Sides	2	¾	6	24
D. Shelf	1	¾	5⅝	15½
E. Partition	1	⅜	4⅞	12⅜
F. Shelf	1	⅜	4⅞	9¾
G. Shelf	1	¾	4⅞	15½
H. Top	1	¾	6¾	18
J. Door stiles	2	¾	2¼	18⅝
K. Door rails (including 2 tenons ⅜ by 1¼ by 1⅜)	2	¾	2¼	13¼
L. Back (wallboard or plywood)	1	⅜	15¾	24⅜

One mirror 11⅛ by 14¾ in., plain or beveled edges; one door pull and catch; one drawer handle; two small lid stays for drop-door shelf; two pair plain butt hinges 1¾ in. wide when open and 2¼ in. long.

All dimensions are in inches.

Your Home Workshop Problems Solved by Experts

FEW questions that arise in connection with your home workshop or such repair jobs as you do about the house have not been fully answered in past issues of Popular Science Monthly. If you had a complete file of the magazine, properly indexed, you would have an encyclopedia of extraordinary completeness.

We are constantly referring readers to past issues, which contain the articles they wish. These back issues are supplied from our own reserve stock at 25 cents each.

Some of the articles to which we have recently referred readers are:

Using Plastic Paint..Jan. and Apr. 1927
Valance Window Boards.....Jan. 1927
Patching Cement Work.....Jun. 1926
How to Replace Sash Cords...Jan. 1927
Toys from Old Tin Cans .....Dec. 1926
Decorative Hanging Bookracks..Jan. 1927
How to Make Dovetails.....Oct. 1926
Brush Lacquering..Aug. and Sept. 1926
Refinishing House Woodwork..July 1926
Refinishing Furniture (varnish) Mar. and Apr. 1926
What Tools Do You Need?...Mar. 1926
Glue in Your Home Workshop..Nov. 1925
Sharpening Your Skates.....Jan. 1926
Ski Sled.....Feb. 1924
Non-Tipping Bob Sled.....Jan. 1924
How to Keep Your Knife Keen Sept. 1926
Woodcraft Cabin.....July 1926
Repairing Electric Cords.....July 1925
Repair of Electric Irons.....Sept. 1925
Hand Planing Machine.....May 1926
Corner Bookcase.....Sept. 1926
Neat Fernery on Simple Lines..Oct. 1925

Transferring Pictures on Glass and Porcelain

By Ernest Bade

PRINTED pictures on paper may be transferred to glass for the purpose of making transparencies or even lantern slides. First thoroughly clean the glass and cover it thinly with dammar varnish or Canada balsam thinned with turpentine so that it flows freely. Set the glass aside until the varnished surface becomes tacky.

The print is stuck in place with varnish

The paper is soaked thoroughly in water and then pressed on the tacky varnish with the picture facing the glass and dried with blotting paper. The paper may be removed by rubbing it carefully with a wet finger. The glass will retain the picture on its varnished surface.

By similar methods prints may be transferred to metal or porcelain. A varnish known as French varnish is used; this consists of gum sandarac, alcohol and Venice or ozonized turpentine. One teaspoonful of gum sandarac is dissolved in about 4 oz. of alcohol and 2 teaspoons of ozonized turpentine are added. Ordinary turpentine cannot be used, as it will not dissolve in the alcohol.

The material upon which the print is to be transferred is covered thickly with this varnish and when the surface is tacky, the back of the paper is moistened, the printed side lightly covered with the varnish, and the print firmly pressed in place. Not less than twenty-four hours later the paper is moistened with water and the fibers are rubbed off.

Under these conditions the print will be reversed. Should it be necessary to transfer the picture as originally printed, it may be accomplished by incorporating an extra step in the process.

Moisten the back of the paper, varnish the picture side quite thickly and let it dry. Fasten a clean sheet of paper to a drawing board and cover it with one or two layers of carpenter's glue. When both papers are dry, the varnished surface, which contains the picture to be transferred, is also coated with glue and pressed upon the prepared paper.

As soon as the glue has hardened sufficiently, the back of the paper containing the picture is moistened with dilute hydrochloric acid, which is absorbed by the fiber. With the aid of a little water, the surface is rubbed gently with a finger to remove the paper. Since the glue is softened by water, the paper must be permitted to dry so that the lower surface will not be destroyed. Then the process may be repeated.

When all of the fibers have been removed, the picture is again visible. It must be varnished, pressed firmly upon the metal or porcelain background, and permitted to dry for twenty-four hours. Finally the paper is soaked in water and removed. Should any glue remain on the picture, it may be washed off.

Television—At Last!

(*Continued from page 13*)

by the coöperation of experts in the Bell Laboratories under the direction of Dr. Herbert E. Ives. Besides planning the research and designing much of the apparatus, Dr. Ives was largely responsible for the development of the photo-electric cell to its present stage. The method of scanning the face or scene by a beam of intense light, as well as the development of special forms of the neon lamp, were the contributions of Dr. Frank Gray, while the apparatus for synchronizing the two ends of the television system was worked out jointly by H. M. Stoller and E. R. Morton.

Their scheme, wonderful as it is, still is far from perfection. Many problems remain to be solved before it can be given to the public. For one thing, the pictures at present are incapable of being "thrown up" on a large screen. Observers at the first demonstration found that while the images, as viewed on the small screen, were clear enough, on the larger screen they appeared blurred and hazy. Before radio scenes and faces can be displayed on a full-size motion picture screen, we are told, 300,000 optical fragments must be transmitted every second, instead of 45,000 as at present.

ANOTHER difficulty is the fact that television cannot be used on a larger screen—in a motion picture house, for example—without throwing a far more powerful light on the face to be transmitted. Even the light used now is strong enough to cause discomfort to the "actor." The development of a more sensitive photo-electric cell, experts say, will be one way of overcoming this difficulty.

To facilitate further research and improvements, the newly organized Federal Radio Commission has set aside a special experimental wave band in the upper part of the present amateur band (between 149.9 and 199.9 meters) exclusively for television experiments.

An official of the American Telephone and Telegraph Company is authority for the prediction that the first commercial use of television probably will be the broadcasting of boxing matches. For this, he said, the present apparatus would require few changes, while other conceivable uses will necessitate considerable improvement. An open air ring contest at night is said to be particularly adapted to the lighting requirements of transmission.

ANOTHER early development, the same official predicted, probably will be the establishment of "television stations" in the larger cities, similar to the "telephoto" stations now operating in a dozen cities. There any person would be able to see and talk with a distant friend face to face.

Whatever the first uses may be, this much seems evident: The coming possibilities of television hardly can be overstated. We cannot begin to guess the wonders it holds, any more than the originators of motion pictures could forecast the screen drama. As with radio, television will be with us almost before we are aware of it, serving us as a vital necessity, contributing in a thousand ways to our comfort and enjoyment.

Magic Signs of Broadway

A WONDERLAND of colored flashing lights, Broadway continues to dazzle New Yorkers and visitors from all over the world with new and constantly changing signs. Magical effects of drifting clouds, leaping flames and surging ocean spray, are the product not only of master electricians and mechanics, but of artists as well.

For one advertising display, intended to portray a house on fire, a burning building was actually photographed. The picture was transferred in colors to a mica disk, in red and yellow for the flames and gray and black for the smoke. Flames were thus drawn in along a complete circle traced on the disk, so that when the mica support was revolved in front of a projector, leaping tongues of fire appeared on the background which completed the effective scene.

The same mica disk artifice is used to represent rain or snow. Spots of appropriate color are painted on the disk, which is then rotated vertically before the projector lens.

On a pirate brig sign advertising a motion picture show, a concealed electric arc periodically causes a blinding flash that mimics the firing of a gun. The effect of ocean spray being thrown over the ship is achieved by the use of four stereoptican projectors.

Flowers That Change Their Sex

AVOCADO blossoms, the flowers that precede a crop of alligator pears, change their sex from morning to afternoon. This was the amazing discovery of Dr. A. B. Stout, of the New York Botanical Garden, seeking a reason for barren orchards planted with alligator pears. He found that certain blossoms were male during the morning and female in the afternoon, and others vice versa.

Science Advances in Spiral

SCIENCE has developed in a sort of ascending spiral, according to Dr. J. Newton Friend, of London, England, lecturing before the Royal Institution. Scientific history repeats itself. For instance, Hero of Alexandria, a Greek physician who lived about 100 B.C., recorded what is generally known as the first steam engine. Later, after centuries of oblivion, the idea was resurrected and made practical. Democritus, another Greek, conceived an atomic theory of matter.

Then science circled about to alchemy, whose backbone was the transmutation of metals—principally of base metals to gold. By the time of Robert Boyle, English physicist of the seventeenth century, alchemy had fallen into disrepute. Now we have done another about-face, for the most learned scientists of the day are again investigating transmutation. But each time we circle back to the same idea, we are on a higher level—science has progressed upward in the intervening time.

SPRING FEVER, that mysterious listlessness that follows on winter's heels, may be due to a lack of vitamines in winter foods, says a British scientist. Sunlight and green vegetables are scarcer in winter, and the deficiency, he says, leaves the body an easy prey to disease germs and minor ailments.

Black Death

(*Continued from page 19*)

"See how we feel, captain?" said the machinist grimly. "Guess we'll all stay—" he glanced at DeFrees—"unless the doctor wants to try his gadget."

"Of course I *do!*" burst DeFrees. Plainly he would not desert his creation even in the face of death. He turned to the commander.

"I can trust you to let me go," he said, half questioningly.

"You can," replied Drake. "That is, if she will let go."

LIKE a snake the wretched man wormed his long body through the doorway of his "Detachable Turret." Drake closed the watertight shield after him. In dead silence the crew watched the curious performance. Presently a small pilot light by Drake's hand blinked. He threw over the releasing lever.

Behind the bulkhead sounded a thump, followed by the *whish-h-h* of inrushing water.

Involuntarily the men crowded forward. For some of them the moment of heroic determination to stick by Drake had passed. Now they saw the last straw of hope snatched away before their eyes. Was it possible that Drake was wrong and the civilian right? How could they judge? One of them groaned aloud.

Drake still stood before the operating lever. Only a few seconds had passed, though it seemed hours since he had made the move that should have sent the inventor hurtling toward the surface. Suddenly, with a cry, he wrenched the operating lever back into place.

"*It didn't let go!*" he panted. "*The man's drowning!*"

Securing bolts were replaced. The turret's door was opened. Into the *X-5* rushed more gallons of water.

Drake leaned through and seized the limp shoulders of DeFrees and hauled him out. The man was half-drowned but still conscious.

One of the sailors brought his hammock, unlashing it as he came. "Here, captain, lay him on this." He placed the bedding on a tool locker raised above the level of the deck about which sloshed several inches of water.

DeFrees allowed himself to be stretched out. Then feebly he raised himself on one elbow. Tears coursed down his cheeks. "I—I suppose I was wrong," he said. He stretched a supplicating hand toward Drake. "You must save us, commander. Only you can do it." He sank back.

THE huddled men swayed like sheep toward their commanding officer. Consternation at the failure of Dr. DeFrees' vaunted device gave way to helpless panic. They were trapped. The frightfulness of it all paralyzed their faculties. The awful choking of gas victims seized one after another.

Now, if ever, Drake must show his leadership. Their only hope lay in somehow enlisting the aid of the *Falcon* just above them.

If only he could get one end of the submarine up, the men might cut their way out. That had been done on the *S-51*. But that boat's pumps worked. The *X-5's* pumps now had collapsed. Moreover, the vast weight of water in her bow anchored her heavily to the bottom.

A dozen wild ideas flashed through his brain. But none congealed to practical form. He gnawed his fist and inwardly cursed his lack of imagination. From time to time DeFrees groaned and babbled feverish demands for Drake to save him. One man sank sobbing to the deck. Another fainted. If only they could be set to work!

Suddenly Drake clapped his hand on Harboard's shoulder.

"I've got it!" he shouted. "There's still a way out."

The men crowded about him, eagerly.

"Here's the idea. Before we left the yard I crawled over the *X-5* (*Continued on page 132*)

Black Death

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from end to end. I noticed that they'd only recently put in new engines. They lowered the cylinder sections down through the main hatch and worked them aft through both athwartships bulkheads. If we can unbolt the engine sections and shift them forward this change of weight ought to let the *X-5* rise on her nose and stick her old stern right out of water!"

A muffled cheer met the suggestion. One would have thought that Drake had announced the boat's arrival on the surface. Instead, as both he and Harboard knew, his plan was but a final desperate move, of which the chances for success were microscopic.

But with a blind faith in Drake all felt that the plan would work somehow. They even talked of the surprise those aboard the *Falcon* would feel when the *X-5's* nose nodded above the sea.

TO HASTEN the work Drake divided his crew into two gangs. These gangs spelled one another every two hours. In the choking fumes every muscular effort was painful. Slowly the men weakened. But in their brave banter none admitted that defeat was possible.

The hours dragged on. Section after section of the sub's long multi-cylindered engine was disconnected and dragged forward by brute force. Slowly the *X-5* was tilting upward.

Twenty-odd fearful hours passed. Brains grew numb and muscles would scarcely respond. But the prisoners struggled on.

Suddenly the whole main deck hove giddily upward as though lifted by an unseen hand. And as suddenly every light went out. All hands slid or stumbled against the bulkheads forward of them. A crash sounded as one of the engine sections broke loose and careened towards the *X-5's* nose. A stifled groan betrayed a poor fellow's foot crushed by the mass.

"*She's up, boys!*" yelled Drake.

His hand flashlight cut the inky blackness. Sure enough, the submarine stood almost vertically. Her athwartships bulkheads had become her decks.

At Drake's direction the chief machinist crawled upward, tapping with his hammer as he went.

"Here she is, cap'n!" called the chief.

His hammer had located the water line. The commander's plan had worked: the *X-5's* stern projected above the surface.

Feverish efforts followed. Drake knew that change of trim might open new seams. He must cut a hole and signal the *Falcon* for a line before the *X-5* sank again.

Only a hand drill was available. The strongest men were assigned to it, ten minutes at a stretch. "*Ah-h-h!*" gasped the first driller to pierce the skin of the boat, as a jet of fresh cold air struck his sweating face. The next instant he groaned. "*Look!*"

DRAKE squinted through the hole. There, indeed, was the outer world at last. But what a world! A stormswept sea; black sky and angry waves with scudding fog masses driving before the wind.

The Falcon was nowhere in sight.

It was the end. Possibly for a few hours the *X-5* might stand in an upright position. It would take days for dying men with the scanty tools available to drill a hole big enough to crawl through. And even if they did not drown or suffocate in the meantime, they could not live in the tempest outside.

Yet even now the commander would not surrender.

"Bring a rod, chief," he called; "one of those bottom sounding rods. And let me have a shirt. We'll just shove a signal flag up through this hole of ours."

And, not to appear to have surrendered, Drake kept those men who could still stand at work drilling away at the steel plating. A woodpecker might as well have tried to pierce Stone Mountain. And all the while the *X-5* imperceptibly but surely settled back toward her level. By midnight but few inches freeboard existed between the tiny vent and the sea level. Every sea shot brine through it upon the shivering wretches within.

Slowly the stern settled. An hour more, at the best, and the *X-5* would disappear forever. In the tempest there was no chance the *Falcon* could ever find the spot again. It might take many months of dragging to locate the hulk. By that time she would be full of sand and unraisable.

With these grim thoughts in his groggy mind and a prayer upon his lips, Drake peered again through the little aperture. Only blackness met his gaze.

BUT suddenly, out of the blackness, came a ghostly glow that lighted the storm-tossed sea. Drake rubbed his eyes. Was it the vision of a brain disordered by the torment of the hours just past? Or was help really at hand?

He looked again. This time he saw a brilliant shaft of light. *It was the beam of a searchlight!*

At the same moment came a long stuttering shriek, unmistakably a naval vessel's siren.

"The *Falcon's* back! She's found us!" screamed Drake and fell exhausted.

The rescue was a feat worthy of mention in the annals of the sea. Oil from the *Falcon* flattened the ugly combers. She maneuvered to windward and made a lee. Perilously her whaleboat worked down upon the *X-5's* sinking stern.

Her chief engineer led the rescue party that crawled out upon the wave-swept black snout. Drenched and shivering, he and his men cut from it a small disk of steel. With his own gnarled hands he hauled the half-dead seamen from their tomb, one by one. Last of all his fingers gripped those of Commander Drake.

Five minutes later the *X-5* gave a great gulp and sank out of sight forever.

In the sheltered waters of Hampton Roads the *Falcon* anchored for disembarkation of the Secret Committee and of the survivors of the *X-5*. Behind closed doors in her small wardroom the Secretary of the Navy gathered his party before he left for Washington.

"Gentlemen, I take it as the consensus of opinion that a detachable cylinder may be all right in theory, but in practice is probably bound to weaken the inherent strength of the submarine."

There was no dissenting voice. Dr. DeFrees, looking ill and shaken, did not raise his eyes.

THE Secretary turned to Drake: "It gives me great pleasure, commander, to tell you that I shall urge the President and Congress to appropriate for a submarine based exactly on your plan. In emergency her main engines or her torpedo tubes can be detached from their foundations and shifted forward or aft. A manhole will be placed in her extreme bow and at her stern. As you have pointed out, this is the simplest and most effective mode of escape for the crew of a sunken submarine."

"Thank you, sir," said Drake, beaming.

Dr. DeFrees rose and stood unsteadily. In a low voice he asked: "May I say a word, Mr. Secretary?"

"Certainly."

"Then I'd like to add that the bravery and devotion to duty of Commander Drake most certainly ought to be recognized by the Government." Holding out his hand, the inventor turned to the officer he had dealt with so condescendingly the day before. "I want to shake the hand of a *real man!*" he exclaimed.

Bare Hands

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The result was a very heavy and sturdy shaft.

"Now for metal bearings," said Thornton.

It was not simple, but by welding a square piece of metal to the end of his shaft, he managed, after a whole day's work, to bore a hole in it, in which the shaft would fit, once the bored section was cut off. Another day saw him make the second bearing, and a third saw the completion of the lathe, with metal bearings and shaft.

"The only trouble with this power plant," he said, "is that one can't take off anything more than a filing or the belt will slip. Still, it works."

They made a forge by the simple expedient of turning a pair of bellows from the furnace around and leading the air through the bottom of a shallow cast-iron pan, in which a charcoal fire served to heat their metal. Then they fashioned many needed tools—tongs, chisels, a crude plane made from the hardest wood that they could find and with the blade held in place by a wedge, a small grindstone that Kelly laboriously chipped out of a layer of sandstone and mounted on the end of the shaft that turned the lathe, another axe, a better adze, two small hammers, and a dozen tools for use on the lathe. Someone was forever hammering on the anvil, making this or that. And at last their equipment was sufficient to warrant their beginning construction of the boat and engine.

"WILLIAMS," remarked Thornton at breakfast, "we'll have to divide up again on this work. You and Kelly work on the boat, and I'll start on the engine. It's the only way to get the job done within a reasonably short time. More of us could work at the boat, but I don't see how all of us could gain much by working on the engine, for it has to be made a piece at a time."

"Right," replied Williams. "Let's go."

It was a week before the keel of the boat was set up, and the stem and sternpost were erected, but the job was well done and sturdy. The ways were placed beside the stream where it widened out after emerging from the ravine at the foot of the cliff. A small sand bar lay across the mouth of the stream, but it served as a breakwater, and could be dug through after the boat was launched. From sunrise until dark every day the party labored, and slowly the boat took shape. She was a modified whaleboat, with the stern cut off square. Her bow was high and her sheer was marked. She was broad and deep and sturdy. Planks for her sides had to be cut laboriously with the adzes out of trees that had been split in half—one plank to each half tree. When they were finished they were heavy and thick, and only with the greatest difficulty could they be made fast. Still, after many days of heavy work, she was planked.

IN THE meantime Thornton had been laboring strenuously at the engine. It took him days to make the patterns for the base and for the cylinder, but once these were completed, the wooden shapes were duplicated in metal within three hours—with Oomak and Kelly helping at the blast furnace. In the first attempt the cylinder, when dug out of the mixed sand and clay that had been carefully prepared for casting, was found to contain a huge bubble in the inside wall where it could not possibly be turned out. So the casting had to be done over again. At last, though, a smooth casting stood beside the well-formed base, and Thornton could turn his attention to other things.

"What reversing link are you going to use?" asked Williams one day when he had gone to Thornton's assistance at the anvil, while the piston head was being made.

"None at all," replied Thornton. "It's hard enough to make the

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thing go one way. It doesn't need to back up."

"I wonder," went on Williams, "if it wouldn't be better for me to help you. Kelly can do a lot on the boat alone, but you need help on this engine. I'll tell you. You and I had better work on the engine, and when we get it made we can both help Kelly."

"We'd probably save time," agreed Thornton, and thus it was that the naval architect turned his attention to the forge and lathe. But he naturally needed much direction and assistance from Thornton.

"What should I start on?" he asked.

"Why, turn out the inside of the cylinder, I guess," suggested Thornton.

"Do you suppose I can manage it?"

"I don't see why not. The lathe is a bit rickety and the tools are crude, of course. But if you are careful you can do it."

"But the lathe won't swing it," Williams hesitated. "The casting's too big."

"I had planned to mount the tool in place of the chuck," explained Thornton. "I fixed a place where the cylinder can slide back and forth along the frame of the lathe, and the tool can turn around. I'll help you get started."

WITH a slot and a wedge Thornton fastened his best tool in place of the chuck, and by sliding the heavy cylinder back and forth along the bed of the lathe Williams managed to get it turned out. Finishing it was equally difficult, but at last the casting was ready to take off. Williams spent all of one day rubbing down the inside walls with fine sand mixed with oil and applied with wads of rabbit skin.

"How about the inlet and exhaust valves?" asked Williams a few days later. "That will be a stumper, won't it?"

"No," replied Thornton. "While you were working on the lathe I made some pretty good reamers. That's why I said a rotary valve would be better than a sliding one."

Once more the big cylinder was put back on the lathe, and before dark a conical hole, that had been cast in an awkward lump of metal on the side of the cylinder, was reamed out until it shone.

"That's enough for now," remarked Thornton. "When we make the valve we'll grind it in by hand."

Days of work for both of them followed on anvil and lathe. The piston rod was forged and turned. The packing box through which it passed in the bottom of the cylinder was made by placing half a dozen metal pins in the bottom of the plate to hold a washer with a hole in the center for the piston rod, and holes around the outside for the pins. The rod was thrust through the washer and through the bottom of the cylinder, strips from their pajamas were wrapped tightly about the shaft between the washer and the plate, and finally, the pins were riveted tightly down upon the washer, forcing the strips of cloth still more tightly against the rod.

THE piston followed, and a groove was cut about it and filled with strips of cloth as the packing box had been. The bottom plate of the cylinder was bored for rivets, holes were bored diagonally from each end of the cylinder wall into the conical hole that had been cast and reamed in the lump of metal on the side of the cylinder, and the cylinder was set up.

Thornton undertook the task of making the crank shaft, building it up in five pieces—first the three bearings, which were hand forged and turned down on the lathe. The ends of these were made square, and in order to build up the shaft, two heavy links of steel were forged with square holes in each end. The squared ends of the main bearings were thrust through these square holes and welded in place, while the connecting rod bearing was welded at the other end of the links. When the crank shaft was completed and Thornton set about testing it, he found that one link was too short, throwing off the line of the shaft. Repairing the trouble was a delicate task, for he had to heat the center of one link without injuring his carefully made bearings, and then, on the anvil, had to beat the link out until it just matched its brother. A flywheel was cast with a square hole in the center for the shaft, and was turned down and carefully balanced on the lathe.

"Why do you want a flywheel on a steam engine?" asked Williams.

"Because our inlet and exhaust valves are not going to be absolutely perfect," Thornton explained, "and I want the shaft to get past the center before the steam comes in and stops the machine, or makes it back up in spite of us. Anyway, the machine isn't balanced at all, and a flywheel will help."

ON THE end of the crank shaft opposite the flywheel a flange was built, to serve the double purpose of a thrust block, to press against the heavy base of the engine when the push of the propeller was to be taken up, and to make the crank shaft fast to the propeller shaft.

The engine had progressed to this point by the time Kelly completed the planking of the boat. Thornton and Williams still had to make the bearings, the connecting rod, the conical valve that was to serve as the inlet and exhaust port, and had, furthermore, to assemble the machine with rivets and pins.

Thornton had learned something of how to make bearings when he had built the ones for the lathe. Now he had only to duplicate that task, except that he wanted three instead of two, and he wanted them cut into two parts. This he accomplished by boring his hole in a rectangular piece of metal that he welded to the lathe shaft. One dimension of the rectangle was a full inch greater than the diameter of the hole he bored. But the other dimension was hardly a quarter of an inch more. Thus, on two sides of this bored-out block, the hole came to within an eighth of an inch of the outside surface of the metal. Along the outside of these thin sections he cut carefully with a cold chisel, and finally had his first bearing in two parts. He ground down the rough edges on the grindstone, and fitted them over the shaft. Two more similar bearings had to be made, and he spent nearly two weeks on the three. Williams, in the meantime, managed to make the bolts and pins that would be needed, and forged the connecting rod as well.

THEY set the machine up. The bearings were riveted in place between the base of the machine and metal caps that fitted above the shaft. The connecting rod bearing was similarly riveted in place, between the lower end of the rod and a cap of metal that fitted around the bearing. The machine was crude, but it was as simple as a machine could be made, and as they turned the flywheel they reached the conclusion that, lavishly oiled, it would serve their purpose.

Only the valve remained to be made.

"Why did you decide on a cone valve?" asked Williams, who had managed to restrain his elation after observing the result of their long weeks of work as it stood between the lathe and the forge. "Wouldn't a slide valve have been better?"

"No doubt," replied Thornton. "But we can't make a perfectly true flat surface, such as a slide valve requires. And we can make a pretty true curved surface. The inside of that conical opening is

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already pretty smooth. When I have turned this cone down a bit, we'll grind it in by hand, and so we'll get it to fit. In the cone I have made inlet and exhaust passages. By turning the cone first one way and then the other, we'll change the inlet port from one of those holes you have bored to the other, and at the same time we'll transfer the exhaust port. It will be simple, and the way we have it rigged up, the pressure of the steam will tend to press the cone more tightly into place all the time."

He was working on the cone as he spoke. It had been forged by hand, and had a flat place on one side running for half its length from the thin end to the middle. On the other side there was another flat place that ran from the middle to the thick end. Thornton had mounted it on the lathe and was engaged in turning it down. He took it out and tried it from time to time in the hole it was meant to fill, and finally called Williams.

"THERE it is, old scout," he said. "All it needs now is to be ground around in there for two or three hours by hand, with a little sand and oil. Here. I have pounded this sand up and strained it through a piece of cloth a couple of times. It will just naturally have to do for emery powder."

Now only the boilers remained to be made before the power plant could be assembled and the boat launched.

The little craft stood sturdily on the ways, decked fore and aft. Amidships, between the two heavy bulkheads, was the space for engine and boilers. Forward the deck was raised to provide for a cabin with four bunks. Aft, a lower deck covered a galley and a mess room—tiny but complete, with seats and a table, very roughly built at the last moment. A stove made of cast iron stood on a shelf covered by a stone held in place by wedges, and a chimney of cast iron led through the deck.

The engine seemed simple enough, and sturdy. It stood five feet high, perhaps, and rested on a heavy cast base. The cylinder had a strange protuberance on one side, and in it the cone valve was mounted. An arm extended from the small end of the valve until it stood out over the flywheel, and there it was bent at right angles. A bearing supported it near where it was bent, and a thin rod connected the end of the arm, which served to rock the cone valve back and forth, with a pin that stuck out of the flywheel two or three inches from the center of the shaft.

But standing as it was, it was no more than so much worthless metal, for as yet there were no boilers in which to generate the steam to drive it, and the four men felt far more like resting than turning their attention to making boilers and rivets.

THE task that faced them was far more monotonous than what they had been doing. They did not dare make a single boiler, for two reasons. In the first place, if a single boiler should give way, it would leave them without power. Then, too, small boilers would be stronger than a large one, and they could generate steam with less danger.

"But they can't be anything more than barrels," remarked Thornton. "They will be hard enough to build that way, without any frills. So we'll make them three feet in diameter and four feet long—perfectly simple—and we'll have to hammer out the plates by hand and rivet them by hand. Thank goodness we can bore the holes on the lathe."

"How about rivets?" asked Williams. "You'll need an awful lot, won't you?"

Thornton smiled.

"I've figured it out," he replied. "Twenty-seven rivets to a plate—forty plates to each boiler—twenty-seven (*Continued on page 136*)

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times forty is one thousand and eighty. Then the ends each will take one hundred and twenty-two. That makes thirteen hundred and twenty-four rivets for each boiler—say twenty-seven hundred for the two."

"Good night!" exclaimed Williams. "It will take a year."

"Not quite," laughed Thornton. "You and Kelly tackle that while Oomak and I make the plates. That's no cinch in itself."

Williams and Kelly, having first cast small anvils for themselves with a V-shaped notch in each one, began pounding out rivets. Day after day they heated bits of metal and pounded strenuously.

THORNTON, meanwhile, was swinging the heavy sledge hammer and Oomak was holding the red-hot metal with two pairs of heavy tongs. Ingot after ingot was pounded into a plate. Plate after plate was gradually added to the pile beside the anvil.

The time came, at last, when the rivet makers had completed their task, but still more plates had to be made. So Williams and Kelly turned their attentions to the lathe, and began boring holes through the plates. Thus it was that when Thornton and Oomak finally completed their terrific task, after nearly a month of steady work, a pile of plates lay bored and ready to be riveted.

First small sheets were riveted together to make one large sheet four feet wide and ten feet long. This was beaten into a curve and the ends riveted together. All day they picked the red-hot rivets from the forge, thrust them through the plates, and clinched them with heavy blows.

Next they made the ends, and hammered the round sheets they had fastened together, into shallow pans, with the edges turned up an inch or so all the way around. Holes were bored through these upturned edges, and corresponding holes were bored through the ends of the boilers. Finally one end was fastened into each boiler, and Thornton laid out the various openings that had to be cut in each one. One opening was for the steam pipe leading to the engine. A second was for the safety valve, and a third for the water gage. This was a float on the end of a steel rod, which was bent at right angles. Marks were made with a cold chisel on the end of the boiler where the gage was mounted, showing what the float would indicate when the water was pumped in.

A SIMPLE hand pump was made to force the water against the steam pressure, the other end of the boiler was put on and riveted in place, and the first boiler, crude and awkward and heavy though it was, stood complete. The task had seemed endless, but now the end was approaching, and they took up the job of finishing the last boiler with thankfulness.

They had been wrecked on that forsaken island when spring was hardly more than half gone, and they had lived there through the spring and all the summer. Now September was upon them. Their beards were long and their hands were calloused. Their muscles were hard and their faces tanned.

But their tasks were simpler now. One of the principal ones was the casting of pipes. They would need three sections each eighteen inches long, one T with places in it for two spigot throttles, and three elbows. They made the patterns very largely on the lathe, and cast them all at once. They riveted the pipe together by means of the flanges with which each section was fitted, and set about testing the boilers.

Their safety valves were simple, conical plugs resting in short, conical cast steel pipes that stood up two or three inches from the tops of the boilers. By weighing Thornton on a balance made of a small tree placed over a sharp rock, they got a pile of ingots exactly his weight, which they still estimated at one hundred and ninety pounds. These were divided into three equal piles, each of about sixty-three pounds, two of which were melted down and fastened to the rods projecting upward from the safety valves. The bottoms of these plugs were circles one square inch in area. Therefore, if the steam pressure came to exceed sixty-three pounds, or thereabouts, the valves, theoretically at any rate, would rise, and the excess pressure would be released.

But they had no idea what pressure the boilers might hold, so they put water in them, built fires under them, and retired to a safe distance, hoping that the "pop valves" would work in time to keep the boilers from exploding. Time after time they had to draw the fires in order to tighten some leaky seam, and what they had thought would be a task that would consume part of a day, turned into a chore that consumed half a week. At last, though, the seams were tight, and the pop valves lifted, permitting long plumes of steam to escape before they settled down once more. The trial was a success, and they were jubilant. Their next job was to install the machinery.

IN CELEBRATION of the completion of this final task before the machinery was hoisted into the boat, Oomak prepared such a feast as he had never before attempted. He had long wondered how he might prepare the dried beans that Kiska Joe had left, and at last he himself became an inventor. Passing the furnace one day, he spied Thornton's casting ladle, and immediately seized it. He had had no pot, and Aleut-like had not thought to ask for one. Now he had found a way to bake his beans.

The meal was a joyous one. The men sat about the table and talked of home and things to eat, of cigarettes and decent clothes, of asphalt pavements and elevators. Soon they would make their bid for freedom and home again. The light from the fireplace threw flickering shadows about the cave, and outside the open door the dark night settled down black and still. The casting ladle, in which the beans had been served, lay empty on the table, with its long handle projecting over the end toward where Oomak stood before the fire, still preparing fish and birds.

THE conversation turned to the next job—that of getting the machinery into the boat. Oomak had just deposited another fish on the table, and turned about to put a stick of wood on the fire, when he started back with a cry of terror. His hand fell upon the handle of the ladle where it projected beyond the end of the table, and the others saw the thing swing suddenly through the air. It clanged against the top of the open door, then fell with a dull thud upon a figure that stood in the dark just outside. There was a cry. A body fell to the ground. A hand reached through the door and lay with its fingers outstretched in the firelight. The hand clenched; a groan came from the dark beyond the door.

The men about the table leaped to their feet, upsetting the benches on which they had been sitting. They saw the long, black hair of a woman falling over a face that it concealed—a face that lay beside the arm that reached from the outside darkness across their threshold to the edge of the flickering firelight.

A woman on this lonely island! Who is she, and how has she come there? Can she, perchance, explain that dreadful cry, or solve other mysteries of Devil Island? Another great installment in next month's issue.

What It Costs to Build

(*Continued from page 69*)

8-in.; with helper .....150 blocks or 133 sq. ft.
Studding, rafters, siding; board measure.....400 ft. B. M.
Floor joists.....450 " " "
Plain board horizontal sheathing, wall or roof.....500 ft. B. M.
Diagonal matched sheathing 300 " " "

In siding and in matched or tongue-and-groove sheathing, the square feet of surface actually covered is about one quarter less than the board measure area given. To find how many studs the carpenter places according to the above figures, apply the rule for board measure: Multiply length in feet by thickness and width in inches, then divide product by twelve. Thus for a stud 2 by 4 by 12 (12 ft. long), multiply latter by two and by four, which equals 96; dividing 96 by 12 equals 8 ft. board measure. Now divide the carpenter's daily stint of 400 ft. B. M. by 8, and we find that he sets up 50 studs of the stated size in a day.

To resume the labor timetable:

Roofing, wood shingles, 700 to 1,000 .....100 sq. ft.
Lathing, wood; 1,200 lath.....80 sq. yds.
Plastering or stucco, three coats; with helper.....20 sq. yds.
Placing window frames in wood building .....6 to 8 frames
Placing window or door frames in masonry.....4 to 6 frames
Door frames, finished with trim..4 frames
Doors fitted, hardware applied....6 doors
Inside stairs with balustrade.....2 steps
Flooring, top or finished floor laid .....200 sq. ft.
Painting, outside wall, one coat 320 sq. ft.
Painting, inside, one coat.....160 sq. ft.
Papering room .....180 sq. yds.

Time estimates for other work:

Steam heat, one-pipe circuit; with helper; per radiator.....1¼ days
Hot water heat, with helper, per radiator .....2 to 3 days
Plumbing, with helper, per fixture, including piping.....1 to 2 days
Electrical work, with helper, metal cable, electric outlets per day.....4 to 6

Plumbing costs six to eight percent of the total house value. Heating is about the same if steam or hot water, but two percent will cover a warm air one-pipe equipment. Wiring a house with metal cable costs usually three to four percent.

The labor in a job of carpentry was estimated at forty percent of material cost a dozen years ago. Since then materials have gone up about twice, while labor has advanced—in some localities—three times. Therefore in those localities today labor and material cost in wood construction are even.

Here are some useful figures for total costs, including material and labor:

Door, outside wall, frame to lock.....	$20.00
Window, two sash.....	16.00
Stairs, interior, per step.....	8.50
Wood porch, 8 ft. wide, per linear ft..	12.50
Floor, double, including joists, N. C. pine, per sq. ft.....	.55
Roofing, wood shingle, per 100 sq. ft..	22.50
Lath and plaster, two coats, per sq. yd.	1.05

While in building there is satisfaction in getting value for your money, economy should not be an end in itself. The cost of a good job will be forgotten in its enduring comfort, but the triumph of undue economy is short lived.

Secrets of "Cold Light"

(*Continued from page 22*)

lighting plants. He has found this efficiency, even for such a low form of luminous life, to be at least twice as great as that of the average electric lighting plant, in which only one half of one percent of the energy of coal burned as fuel is converted into light.

Luminous bacteria sometimes grow on animals, causing the latter to appear luminous. Sand fleas thus infected shine brightly in the seaweed. Certain fishes house the bacteria. The most remarkable is a deep-sea fish called *Photoblepharon*, or "light eyelid," discovered in the depths of the Banda Sea, Dutch East Indies. The *Photoblepharon* forms a queer partnership with microscopic light givers, providing them with board and lodging in return for illumination. The bacteria are supported just beneath the eye, where they form an ever-burning lantern.

As a means of shutting off the light, the fish has developed a curtain of skin, resembling an eyelid, which it can draw over the luminous spot. It uses this queer lamp as effectively as luminous fishes that supply their own light.

EVEN human beings occasionally exhibited much the same sort of luminosity. Sometimes, before modern medicine and surgery, wounds became infected with luminous bacteria which caused them to glow at night.

And then Mrs. Christine Ladd-Franklin, of Columbia University, recently advanced before the American Optical Society the theory that human nerves emit light, much as do the lamps of the firefly and glowworm. Mrs. Ladd-Franklin claims that under certain conditions a network of light can be seen to originate from the nerves lining the back of the eyeball, appearing as an illuminated nerve inside the eye. It is probable, she suggests, that all our nerves have this luminous power.

Doctor Harvey and others have revealed the process by which living light is produced. The raw materials are oxygen and water. The "power plant" which produces the light contains a luminous secretion which can be separated into two distinct parts. One of these, called luciferin, consumes oxygen to produce the light. The other, known as luciferase, is a catalyst, or transforming substance, which speeds the process. The exact chemical nature of luciferin and luciferase remains a mystery, though the former is believed to be a protein, while the latter is related to the albumins.

THE amazing thing about luciferin as a light maker is that it never seems to burn out. When you burn coal or oil as fuel, it combines with oxygen and vanishes as gas. But when luciferin combines with oxygen it becomes a luminous substance, called oxy-luciferin, which is not lost, but returns again to luciferin when the light goes out. Then it is ready to be lighted again.

This is what happens when the firefly flashes its light on and off. It is somewhat as if you had an electric flashlight, whose battery would renew itself after every flash and continue to renew itself indefinitely.

"It is an extraordinary process," said Doctor Harvey. "The economy of it is evident. It is already possible to devise a lamp in which luciferin is burned continuously over and over again. To be sure, the light is weak, but the principle of operation remains. Perhaps we may look to an application of this principle for development of new means of illumination."

Such development, involving the manufacture of artificial luciferin, would supply the world with the ideal light, and at less cost.

Forty-Niners of 1927

(*Continued from page 28*)

twenty-five years without showing anything but low grade ore. In fact, young Frank Horton's father had lost money tracing veins that yielded nothing better than $12 a ton. Then, by chance, the boys found their fortune.

The wealth of the strike is described by Fred Gilbert, a young desert prospector:

"I broke open a chunk of rock about six inches in diameter," he tells, "and found the whole inside plastered with free gold. Other boulders disclosed the same values. They were at least sixty percent gold."

An Oakland, Calif., newspaper reporter told of seeing a single handful of crushed rock yield two tablespoonfuls of gold when panned.

The lure of gold is as old as history. From the earliest civilizations possession of gold has meant power and wealth, and it has become the world standard by which the value of all things is measured. It represents concentrated labor. In ancient times it was precious chiefly because it was the rarest of known metals; but not today. Platinum, cobalt and nickel are scarcer. Radium is priceless in comparison. Indeed, gold is as plentiful as copper, tin and lead. It can be found almost everywhere in rocks and soil, even in the ocean.

IN AUSTRALIA men actually make a living by extracting gold from the waves, and scientists are seeking methods of taking the metal from the seas in better-paying quantities. Gold is rare merely in the sense that in few places is it found in quantities sufficiently concentrated to pay large rewards.

Men today prize gold for its appearance, its hardiness, its usefulness. Its rich, yellow luster endures indefinitely. It neither rusts nor tarnishes readily. The metal itself, one of the elements of nature, is all but imperishable. It is proof against attacks of all ordinary acids. Moreover, of all metals, gold can be worked most readily by craftsmen. A single grain can be beaten into a thin leaf fifty-six inches square, or drawn into a wire 500 feet long! Yet it is so strong that a golden wire only sixty-five thousandths of an inch thick can support the weight of a 150-pound man!

We often hear of "pure gold"; yet few ever have seen this. Gold from the mines is never pure; it is an alloy of gold and silver, sometimes with traces of iron and copper.

REFINING processes separate the other metals from the gold; but we rarely use pure gold, because it is too soft to withstand rough wear. All our coins and ornaments are alloys of gold with copper or with copper and silver. United States coins contain nine parts of gold to one of copper.

Jewelers measure the purity of gold by carats, or twenty-fourth parts. Thus, pure gold is said to be twenty-four carats fine. Most jewelry is not more than eighteen carats fine.

In the last 500 years, it is estimated, men have mined more than 18,000 tons of gold. And they have hardly scratched the crust. Alchemists of old spent their lives endeavoring to create gold from baser metals. Modern magicians of science, seeking the same goal, have reported success in changing mercury into gold, though not profitably.

Some day science, discovering new secrets of matter or delving into the earth or plumbing the mysteries of the sea, may make gold cheap as dirt and put an end forever to stampedes. Meanwhile, the glittering rock of Weepah makes men's hearts beat fast with excitement, and the rarest gamble in the world builds tented mining camps overnight.

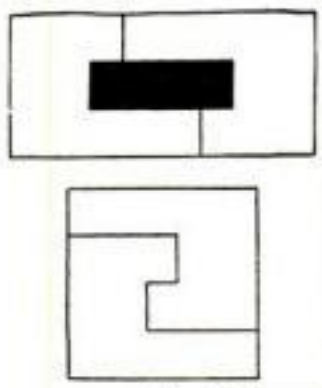
Answers to the Sam Loyd Puzzles on Page 67

The Tree Riddle

Translate 150 into Roman numerals, CL, and combine the letters with OAK, and you have CLOAK as the answer. You should have guessed that within five minutes.

Dividing the Apples

The full names of the four girls are Ann Jones, May Robinson, Jane Smith and Kate Brown. Twelve minutes earns a high rating.



The Zulu Battle Flag

The diagrams show how the white part of the flag can be dissected into similar parts that fit together as a square. Twelve minutes gives a good rating.

The Beheaded Words

The beheaded words are: Crave, crate, fable, gill, hand, harm, hash, keel, knave. This should have been a ten-minute exercise.

An Elfish Equation

There are five boys on one side and three on the other. Cancellation leaves two on one side. There are six girls on one side and three on the other. Cancellation leaves three girls on one side balancing against the two boys. Therefore, a girl's weight is two thirds that of a boy. Eight boys on one side of the seesaw, therefore, would require twelve girls on the other to effect a balance. Five minutes is good time.

Counting the Votes

The loss of 11 votes to the apparent winning side made a difference of 22 in totals. That difference, 22, was equal to one more than one third of the minority on the first count. Therefore, 21 would equal a third, and 63 must have been the number of those seated. The standing vote, being one third greater, must have been 84. The total number of voters was 147. This is a ten-minute problem.

How the Sisters Shopped

Martha and Gertrude started out with $29. Martha paid $8.50 for her hat, $6.50 for her shoes. Gertrude paid $8.50 for a blouse, $5.50 for her parasol. Had Martha bought a $6 pair of shoes and Gertrude a $9 blouse, they would have each spent $14.50. Ten minutes is good.

Answers to Tests, Page 34

Terms of Applied Science

1.—Armature; 2.—Filament; 3.—Carburetor; 4.—Ammeter; 5.—Bessemer converter; 6.—Turbine; 7.—Cyanometer; 8.—Gyro-stabilizer; 9.—Radioactivity; 10.—Pasteurization.

Inventors and Inventions

1.—Watt, 1769; 2.—Morse, 1837; 3.—Edison, 1893; 4.—Newton, 1687; 5.—Westinghouse, 1868; 6.—Roemer, 1675; 7.—Kepler, 1609; 8.—Howe, 1845; 9.—McCormick, 1834; 10.—Bell, 1876; 11.—Gatling, 1861; 12.—Galileo, 1609.

Mental Measuring Stick

1.—5280; 2.—2204.6; 3.—640; 4.—43,560; 5.—57¼; 6.—.4; 7.—6,080; 8.—.000039; 9.—6,000,000,000,000; 10.—231; 11.—6; 12.—660.

Application of Measurements

1.—25,000; 2.—1,100; 3.—256; 4.—239,000; 5.—459.4; 6.—29.5; 7.—186,000; 8.—6,000,000,000,000,000,000; 9.—93,000,000; 10.—39; 11.—62.5; 12.—29,141.

City Populations Predicted

(*Continued from page 25*)

population of approximately 1,730,000,000, this planet can support 8,000,000,000 persons—more than four times as many as there are now. At present, only twenty-eight percent of the world population is in the tropics.

Europe and Asia today support nearly four fifths of all the world's inhabitants; in another three hundred years, Professor Penck estimates, the Europe and Asia total will have increased another half billion—and still be only a quarter of the world's whole population. North America, he believes, will eventually support 600,000,000 people—some 200,000,000 in the United States, the balance in Canada, Alaska, Mexico and Central America. He believes that Australia will have eventually a total population of something like four hundred and fifty million. But the densest population will exist near the equator; he gives Brazil a future population of 1,200,000,000.

IN THE John Hopkins' estimates, the shift from rural to urban population is significant. It is possible, from them, to calculate what the great cities of the country will grow to be, fifty or a hundred years from now. Even though the total population of the United States will apparently increase little more than fifty percent in the next seventy-five years, many of the larger cities will double, even treble, their present population. Taking the "law of growth" as a basis, it is possible to work out an estimate of what the leading cities of the country today will grow to be by the end of the century. Here are figures, based on their early "growth curves," of ten cities and their probable populations at the end of the century:

	1920	2,000 A.D.
Chicago	2,701,705	5,400,000
Detroit	993,678	4,750,000
Los Angeles	576,673	4,125,000
Philadelphia	1,823,779	3,575,000
Baltimore	733,826	1,725,000
St. Louis	772,897	1,556,000
Boston	748,064	1,450,000
Seattle	315,312	1,175,000
San Francisco	506,676	1,141,000
Pittsburgh	588,343	893,000

Of course, these are only rough approximations, dependent on the theory that conditions of growth will remain comparatively unchanged. At any time new conditions may mean starting out on a new basis—as Detroit and Los Angeles have already done. Also, with such figures as that for San Francisco, no account is taken of neighboring cities like Oakland and Berkeley across the bay, Alameda and San Raphael. Together they may form an imposing group, rivaling anything else on the Pacific Coast. In the same way, Seattle and Tacoma may form part of a great Puget Sound unit.

IN THE South conditions are already changing so rapidly that it is impossible to say what tomorrow will bring. Fort Worth or Houston may be jumping forward in another ten years in a way that will make even the phenomenal growth of the last decade seem merely a beginning. New Orleans, or Atlanta, may see the start of a boom that will equal the recent Florida excitement. And no one knows what Florida cities will do.

But the great metropolis will continue to be New York. Dr. Pearl and one of his associates, Prof. Lowell J. Reed, have calculated the New York figures in full. In spite of the fact that the lower east side holds already the most densely populated district in the world, with 219,256 people living in a total area of less than three quarters of a single square mile, they estimate that the growth of New York will continue until the present population has more than doubled!

The population of New York City, on July 13, 1925, was 6,103,384. By 1930, Professors Pearl and Reed estimate, it will be 7,032,000. But that is only for the metropolitan district itself. In the suburban area that is fed by New York as a center, the 1930 figure is 11,450,000. By 2000 A.D., the figure for the total area will be 28,765,000, and for the city district alone 13,948,000.

Think what that means! Already, on one corner, 40,000 people pass in a single hour. Crowding seems to have reached an absolute limit. What will the condition be fifty years from now, with the population doubled? How, in the year 2000 A.D., will that great New-York-area population of nearly 29,000,000 be housed, transported, fed? The answers to those questions will be told in another article to appear in an early issue.

Wonderland of Science

(*Continued from page 44*)

mission units." This did not satisfy the scientists. They wanted a more delicate test than one in which a man listened to sounds and guessed at their relative loudness. They had found out another interesting fact—that while the human ear is not infallible when it comes to comparing two sounds, it can always note even the slightest difference between them. Put two loudspeakers side by side, and the ear can tell when they sound alike.

So they took a loudspeaker that was conceded by judgment alone to be a good one. They worked with it and adjusted it until the ear could detect no change of volume when the pitch of the notes it responded to changed suddenly. All sounds reached the ear with almost perfect uniformity. The scientists recorded and tabulated any slight variations. They labeled it, "Standard Loudspeaker."

Now whenever a loudspeaker is tested, they set it up alongside the standard instrument and try them out together. Throughout the entire range of sounds, the new speakers' peculiarities are charted.

No abstract tests, these; no applying of an arbitrary voltage to a set and measuring its response to some arbitrary electric current. Here, hooked up to a full sized antenna, the receiver actually receives.

Graphic diagrams show what different makes of sets will sound like. Here is a curve that starts off enthusiastically on the low notes, to trail away and die when it reaches the middle of the chart. "That set," Senauke says, "gargles and bellows—you can't understand a word it says." For speech is a matter of high frequencies. The best sets respond to the high-pitched tones by which you recognize a friend's voice, not alone the lower notes that merely carry the "body" of the sound.

Another curve leaps up from the middle of the chart, rises to a dizzy height, and then drops away as fast as it rose. Grating, scratching and hisses will greet the man who turns on that set. Here is a curve with its peak at the high end; that promises to give a brilliant high-pitched tone, a good quality for speech, but no mellowness at all. It will leave out all the bass notes of an orchestra.

Clear across one chart undulates a curve in what is nearly a straight, horizontal line. "The set that made that curve," Senauke said, "is about as near perfect as you'd hope to find. You can hardly sing a note, or hit one on a musical instrument, that it won't respond to."

Strange curves—charts on paper from which, as by wizardry, they are finding out things you want to know about tools and radios.

How Sea Flying Was Made Safe

(*Continued from page 33*)

banks grew thicker, the river traffic denser, until the clamor of sirens penetrated even above the noise of his engine.

Now the towering skyline of Manhattan came into view. He swung almost to the edge of the Palisades, then straight to a landing field at the northern end of the island. While his assistants filled the gas tank, Curtiss rushed to telephone the editor of the *World.*

"I have landed in New York City," he announced, "but I am going on down to Governors Island."

New York's millions watched, unbelief changing to amazement among the throngs that jammed windows and roofs along the river front. Curtiss flew out of his way to circle Liberty's torch, then dropped to a perfect landing on Governors Island parade ground.

One hundred and fifty-two miles he had flown, in an actual time in the air of two hours and fifty-one minutes, at an average speed of fifty-two miles an hour.

"A wonderful performance!" exclaimed General Frederick Dent Grant, commanding officer at the Island, as he seized the flier's hand.

PEOPLE at last admitted that aviation had "arrived." Flyers everywhere were inspired to seek new records for air travel. Charlie Hamilton flew from New York to Philadelphia and back on June 13th in a Curtiss plane; the first round-trip flight between two large cities, winning the prize offered by the *New York Times.* On the 4th of July Curtiss at Atlantic City won the $5,000 prize for the first aviator to fly fifty miles over the ocean. On the same day Walter Brookins in a Wright machine made a new world's altitude record—6,000 feet. Then, on August 30th, Curtiss made another world's record, the longest flight over open water, sixty-four miles over Lake Erie from Cleveland to Cedar Point and back again, in a driving rainstorm.

Aviation meets were held everywhere, the summer of 1910. Exhibition flying at Sheepshead Bay, New York, in August, with five Curtiss flyers in the air at once; a marvelous spectacle. Here McCurdy, of the old Aerial Experiment Association, first demonstrated wireless communication between a plane and the ground. Claude Grahame-White came from England with a Bleriot monoplane and at Boston beat Curtiss by a slight margin. And that was the end of Glenn Curtiss' air racing. Just as in the old bicycle days he stopped racing when he was beaten at Syracuse, now he concluded to let the younger fellows, his pupils, do the exhibition flying and racing while he devoted his time to developing the airplane, inventing improvements.

THE international challengers went after the Gordon Bennett cup again that summer. Curtiss had built a monoplane, but at the last minute decided not to fly in defence of his trophy. Eugene Ely competed in a Curtiss biplane. A. J. Drexel, Jr., was a contestant in an imported Bleriot. The Wright brothers entered. So did Hamilton. Alfred Leblanc, the French contestant, had probably the fastest machine, but crashed into a telegraph pole at Belmont Park, and Grahame-White, the Englishman, flying a French machine, took the International Cup back across the Atlantic.

Now the Army and Navy began to get interested in flying. Congress made trifling appropriations for flying experiments—$125,000 for the Army, $25,000 for the Navy! Curtiss offered to teach, without charge, all the Army and Navy officers whom their departments might detail to learn to fly and, early in 1911, established the famous (*Continued on page 142*)

How Sea Flying Was Made Safe

(*Continued from page 141*)

flying port at San Diego, with five pupils.

Now, besides getting the Army and Navy into the air, Curtiss wanted to demonstrate his own earliest theory that flying over water could be made as safe and as practical as flying over land. The *New York World* suggested transportation by airplane of a message from a ship at sea to shore. A platform was rigged on the after deck of the Hamburg-American liner *Pennsylvania*, from which McCurdy was to fly back to New York from outside Sandy Hook. But a careless mechanic left an oil can on the platform. McCurdy's propeller struck it and was shattered, and that first experiment proved nothing. But the cruiser *Birmingham* was rigged with a similar platform, and on November 14, 1910, Eugene Ely flew from ship to shore at Hampton Roads, Virginia.

It seems commonplace enough now, but the whole world got excited over that feat. "Now fly from shore to ship," said the Navy, and on January 18, 1911, Eugene Ely made a successful shore to ship flight, landing on the deck of the U. S. S. *Pennsylvania* in San Francisco harbor.

At San Diego Curtiss and his mechanics were busy building planes that would float, reshaping, rebuilding the pontoons, until one day late in January, 1911, Curtiss took one of them out to see how it would behave on the water.

"I HAD no idea of going into the air at that time, though I knew it was possible," he told me. "Nobody had ever risen from the surface of the water. But this machine handled so beautifully that my action in elevating the plane was more instinctive than intentional. One second I was skimming the surface of the bay and in another I found myself in the air. It rose with a suddenness and ease that surprised me. I flew half a mile over land, turned and alighted on the water. Several naval craft in the bay tooted their sirens in applause. I rose again from the water, this time intentionally, and again alighted. I had got what I was after."

Now men could fly anywhere. First the land routes had been conquered, now the sea. Only time and money were needed to reduce the problem of world-wide flight to practical accomplishment. Now the airplane could fly from the shore to any ship, or from one ship to another, alighting on the water and being lifted aboard by the ship's tackle, as Curtiss himself proved within a few days, when he flew out to the *Pennsylvania*, was lifted with his plane to the battleship's deck, was lowered again to the water and flew back to shore.

THAT was another great aviation year, 1911. The Navy bought two of the new hydroaeroplanes. The Army bought four or five aircraft. The first mail ever carried by airplane was taken from Mineola, N. Y., to Garden City by Capt. Beck, with the Postmaster General of the United States as a passenger. Curtiss' agents visited Europe and South America, selling planes to France, to Russia, to Brazil. Then, on December 5, 1911, the United States Patent Office granted the patent application of the Aerial Experiment Association, a patent on the aileron.

The Aero Club of America crowned a triumphant year for Curtiss by awarding to him the Robert J. Collier trophy for the most significant advance in aviation during the year, and issuing to him Air Pilot's License No. 1.

But Glenn Curtiss wanted an aircraft which could float, navigate the water—a flying boat. In November, 1911, he made a secret trial of such a craft, and on January 10, 1912, the flying boat flew.

Meantime the injunction which the Wrights had obtained, restraining the sale of aircraft by the Curtiss Company, had been dissolved, though the patent litigation was by no means at an end. Extension after extension was made to the motor and plane shops at Hammondsport until, by the end of 1912, Curtiss' company was turning out an airplane a day.

One question now was on everybody's tongue. "Who will be the first to fly across the Atlantic?" Rodman Wanamaker, merchant, sportsman and aviation enthusiast, commissioned Curtiss to build a bigger flying boat with a bigger hull than anything that had gone before, and arranged with Lieut. J. C. Porte of the British Navy to undertake a trans-Atlantic flight. Work on this flying boat, the *America*, was begun in December, 1913. It was almost ready to fly when, in August, 1914, Germany and Great Britain went to war. Lieut. Porte was recalled for service and the *America* was bought by the British Government for submarine-detecting patrol duty.

IN THE meantime two honors had come to Curtiss which, among all of his aviation triumphs, he cherishes most highly. First was the award to him, in May, 1914, by the Smithsonian Institution of Washington, of the Langley medal for aerodromics, a pound of pure gold, presented for services in the development of artificial flight, and received from the hands of his pioneer associate, Prof. Alexander Graham Bell. The other was his selection by the Smithsonian Institution to prove that Prof. Samuel P. Langley, the Institution's famous secretary, had actually built a flying machine that could fly.

Curtiss took the old Langley aerodrome of 1903 from its resting place in the National Museum, and shipped it to Hammondsport. What happened then is perhaps best told by the inscription on the placard set up in front of the machine, in the Museum at Washington.

"In 1914," the inscription reads, after describing Professor Langley's ill-fated efforts to make his machine fly, "the experiments were resumed, using all available parts of the original machine. The frame and engine were the same as in the first trials; the reconstructed wings were used without the leading edge extension; the control surfaces were reconstructed; and launching pontoons with necessary trussing were substituted for the original catapult. Thus equipped, and weighing over forty percent more than in 1903, with Glenn H. Curtiss as the pilot, it was successfully flown at Hammondsport, N. Y., June 2, 1914. With a more powerful engine and tractor propeller, it was subsequently flown repeatedly. These tests indicated that the original machine would have flown in 1903 had it been successfully launched. After the Hammondsport flights the machine was restored in accordance with the original drawings and data under the supervision of one of the original mechanics, using all original parts available. In 1918 the machine thus restored was deposited in the National Museum for permanent exhibition."

IN A few short months all Europe was at war. Germany alone had airplanes, dirigibles, equipment for war in the air. France and England were caught unprepared. Nowhere in the world had anybody but Glenn Curtiss ever built two airplanes alike. Nowhere else was there a factory equipped and ready to turn out planes and motors at high speed.

"The British Government wants you to build all the planes you can as fast as you can," was the substance of the message Glenn Curtiss received through the British Embassy at Washington.

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How Sea Flying Was Made Safe

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"What kind of planes do you want and how much will you pay for them?" he replied.

"Whatever kind of planes you can build at whatever is a fair market price," was the answer, in response to which every other activity of the Curtiss plants was suspended.

That almost ends the story of Glenn Curtiss as an individual pioneer of the air. From then on it is the story of the Curtiss companies, capitalized by Wall Street financiers, building planes for Great Britain, planes for the United States Army and Navy, merging patents with the Wrights and all the other airplane builders, at the demand of the United States Government, in the patent pool of the Manufacturers' Aircraft Association. It is the story of the coöperative development by the Navy and Glenn Curtiss of the flying boat into the "N. C." type, one of which, the *N. C. 4*, a few months after the Armistice, was the first flying craft to cross the Atlantic.

GLENN CURTISS today still dreams of aviation, although at the moment he is more interested in building new communities in Florida. We sat on the veranda of his rural lodge at the northern edge of the Everglades. There he told me most of what I have set down in these articles.

"We have only just begun to learn how to fly," he said. "This is only 1927; it was less than nineteen years ago that I made my first flight. More has been done in the eight years since the war ended, toward the real development of aviation, than in the eleven years of flying before that. War called for high power, light weight, great maneuverability—the essentials of stunt flying. It put a stop for years to developments looking toward safety, endurance, stability in the air, the essentials of commercial air navigation. Some day," he went on, musingly, "I may start building planes of a different type from any that have yet been constructed. Everybody who has an interest in aviation owes it to himself and to the public to do everything he can to make passenger and freight flying as cheap as railroad transportation, as popular as the automobile, and safer than either."

What Is New This Month

(Continued from page 3)

Here Are Correct Answers to Questions on Page 51

1. The harbor of Pago Pago on the island of Tutuila southwest of the Hawaiian Islands. The ancient volcano that forms the island sank so that the sea broke into its crater, forming the beautiful harbor now occupied as an American Naval base.

2. At the south end of Monterey Bay, California, lies the Monterey Peninsula, on which grow two remarkable species of trees—the Monterey cypress and the Monterey pine. These grow naturally nowhere else in the world. The twisted weirdly-shaped trees so often seen in pictures of Monterey belong to this strange and vanishing kind of cypress.

3. This still is a mystery. Scattered over the eastern half of the United States are roundish hills and long mounds, sometimes shaped like serpents, constructed long before the white men came to America. Scientists believe they were built by the ancestors of the American Indians.

4. Because the Bermuda Islands possess no streams. The roofs are used to collect rain water for water supply, and for sanitary reasons it is necessary that the roofs be kept clean and whitewashed. The water is stored in tanks and cisterns.

5. Because the peculiar straw out of which the best grades of Panama hats are woven, known locally as "paja toquilla," grows in Panama. The hat-making process is a rather complicated one of soaking and working the straw in addition to weaving.

6. On the River Towy, in southwestern Wales, you still can see boats constructed exactly as they were in Roman times.

7. The floating islands of the Nile are really masses of the famous papyrus plant, that supplied the Egyptians with their paper. Matted masses of the plants frequently are torn loose by the current and float as actual islands, large and strong enough to support many men.

8. They were gardens built on top of a structure of great arches, such as the arches that support modern stone bridges, because Babylon was very flat and subject to floods. Water for irrigating them was brought up by bucket pumps worked by slaves.

9. This used to be a more or less common medicine all over the world. At present, so far as is known, the common use of the monkey-ash medicine survives only in Siam, where native doctors consider the ashes a valuable remedy for consumption and other diseases of the throat and lungs. Gradually, however, modern medical knowledge is spreading into these remote countries, too.

10. Nearly two thirds of the world's supply of tin comes from the southern part of the Malay peninsula. Politically this country is under British protection and is known as the Federated Malay States.

11. In ancient Babylon more than five thousand years ago the people settled along the banks of the Tigris and Euphrates constructed a great network of irrigation canals, dikes, and storage reservoirs, by which the water of the two rivers was distributed over the plains.

12. These two rivers are branches of the Nile, south of where it divides at the city of Khartum. The names refer to the appearance of the water. The White Nile is usually milky from fine rock dust suspended in it. The Blue Nile contains little mud and is clear and blue.

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